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APPENDIXES 5–6

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Published monthly by the

University of the State of New York

BULLETIN 278 FEBRUARY 1903

New York State Museum

FREDERICK J. H. MERRILL Director

Bulletin 60

ZOOLOGY 9

CATALOGUE OF THE

FISHES OF NEW YORK

BY

TARLETON H. BEAN M.S. M.D.

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University of the State of New York

New York State Museum

FREDERICK J. H. MERRILL Director

Bulletin 60

ZOOLOGY 9

CATALOGUE OF THE

FISHES OF NEW YORK

PREFACE

In 1836, under the influence of public interest, Secretary of State John A. Dix presented to the legislature a plan for a natural history survey of the state, which was carried out with success and credit and resulted in the publication of a large number of valuable reports. Not the least important of these were the contributions of James E. De Kay to the zoology of New York, which appeared in 1842 and 1843.

Since that time comparatively little official recognition had been given to the progress of biologic study, till in 1897 the writer secured the able services of Mr Gerrit S. Miller jr in preparing a preliminary list of New York mammals. Following this appeared in October 1900 a key to the land mammals of northeastern North America by the same author, and in April 1900 a check list of the birds of New York by Dr Marcus S. Farr, who is now engaged in the preparation of a detailed catalogue of the birds of New York. A list of reptiles and batrachians by Messrs Eckel and Paulmier has recently appeared; and in the present bulletin Dr Tarleton H. Bean gives to the citizens of the state the benefit of his natural talent and long training as an

ichthyologist. It is hoped and believed that the results of this work will be of much practical use to the public at large and to the teachers and students in the schools of the state.

By special request of the author his synonymies are printed in the form in which they were prepared by him.

FREDERICK J. H. MERRILL

Albany N. Y. July 1902

New York has an extensive water area and a great diversity of surface. Its principal drainage basins are: the Great lakes, the St Lawrence river, including Lake Champlain, the Ohio basin, the Susquehanna, the Delaware, the Hudson and several small streams adjacent to it in the southeastern part of the state. The inland lakes, in the central and western part of the state, almost all communicate with Lake Ontario. Chautauqua lake belongs to the Ohio basin. Lake Otsego and two small lakes east of Keuka lake, empty into the Susquehanna. The Adirondack lakes for the most part belong to the St Lawrence drainage basin, some of them emptying into Lake Champlain, and a few into the upper waters of the Hudson.

Long Island has a larger number of species than all the remainder of the state. The number of marine species in its waters is 217, and its fresh waters contain 27 species, of which 13 have been recently introduced.

In the bays of the south side of the island, wherein the water is brackish or nearly fresh, and where there is a luxuriant growth of water plants, young menhaden and alewives are extremely abundant.

One of the fresh-water fishes is a hybrid trout, artificially produced; another is the black-nosed dace, which is perhaps doubtfully recorded from Long Island; and 13 species have been recently introduced, as before remarked.

The permanent residents in fresh water are the following: horn pout, chub sucker, roach, brook trout, striped mud minnow, banded pickerel, chain pickerel, fresh-water killy, pirate perch, fresh-water silverside, sunfish, yellow perch, and Johnny darter. Most of these 13 species, or perhaps all of them, could easily have been introduced by man within the last century or two.

Mitchill recorded only three fresh-water species from Long Island. These are: yellow perch, brook trout and pickerel. To the pickerel he applied the name Esox lucius, a species

which does not occur on the island. He mentioned also the bony-scaled pike, Esox osseus, concerning which he says, "A few years ago I had a large and complete specimen from Long Island, which agrees in the main with the descriptions extant." This was doubtless a mistake of locality. The yellow perch was transplanted by Mitchill in 1790 from Ronkonkoma pond to Success pond, in Queens county, a distance of 40 miles. Prior to 1790, he states, there were no yellow perch in Success pond. De Kay also knew only a few species of fresh-water fishes in Long Island waters—the yellow perch, roach, banded pickerel, and brook trout.

It seems probable that some of the early writers on New York fishes must have had access to collections from Long Island, and yet a number of species might have existed without discovery during the time of their observations. The present number of species whose date of introduction is not recorded is very small, and most of the so called native fishes represent species which lend themselves readily to the purpose of artificial introduction.

It is a matter of record that some species of fresh-water fishes identical with those found in Long Island waters, have been swept out of the Hudson river by spring floods, and several such species have been seen at Gravesend bay, Long Island. It is certain that incursions of fresh-water forms could have taken place from time to time in the streams of the north side, and also on the south side of Long Island. Once established in that way, their wider dissemination through the agency of man, aquatic birds, and even through their own movements could be very easily accomplished.

Of the fresh-water fishes known to Mitchill and De Kay, the brook trout can live in fresh and salt water indifferently; the chain pickerel is frequently found in brackish water; the yellow perch is one of the fish which have been brought down from the Hudson by floods into Gravesend bay; the roach is a common resident of lakes in New York and Brooklyn parks, and its distribution has been greatly extended through the agency of man.

The number of fishes included in this catalogue is 375, of which 371 are named, and the following four, which have only recently been discovered in the state, should be added to the list: no. 76½ bullhead minnow, no. 91½ silver-jawed minnow, no. 94½ silver chub, no. 255½ northern darter. Of these species 217 are marine, 141 fresh-water, and 17 anadromous. The number of introduced species is 15, and the number whose occurrence in New York waters is doubtful is 18. The small number of fresh-water species would be remarkable but for the fact that no extensive investigations have recently been made of the fresh waters of the interior of the state, and the catalogue is in that respect simply incomplete.

The anadromous species are the following: no. 1 sea lamprey, no. 35 common sturgeon, no. 37 short-nosed sturgeon, no. 101 eel, no. 112 hickory shad, no. 113 branch herring, no. 114 glut herring, no. 115 shad, no. 130 quinnat salmon, no. 131 Atlantic salmon, no. 134 steelhead, no. 137 rainbow trout, no. 143 smelt, no. 170 10-spined stickleback, no. 171 two-spined stickleback, no. 260 striped bass, no. 261 white perch. Besides these, the following marine species occasionally run up into fresh water for shorter or longer distances: no. 158 silver gar, no. 223 bluefish, no. 224 crab-eater, no. 321 naked goby, no. 346 tomcod, no. 368 hogchoker.

The introduced species are: no. 71 tench, no. 74 golden ide, no. 99 goldfish, no. 100 carp, no. 130 quinnat salmon, no. 131 Atlantic salmon, no. 132 landlocked salmon, no. 133 Lake Tahoe trout, no. 134 steelhead, no. 135 brown trout, no. 136 Lochleven trout, no. 137 rainbow trout, no. 138 Swiss lake trout, no. 141 saibling, no. 142 golden trout.

The fishes whose pertinence to the New York fauna is doubtful are the following: no. 73 Leuciscus margarita, no. 162 longbeak, no. 208 amberfish, no. 226 small dolphin, no. 262 wreckfish, no. 263 spotted grouper, no. 265 coachman, no. 290 Zenopsis, no. 391 globefish, no. 302 hairy bowfish, no. 303 burfish, no. 317 sea poacher, no. 327 shanny, no. 328 blenny, no. 329 snakefish, no. 337 red gurnard, no. 356 cusk, no. 359 rough dab.

The fishes represent 99 families. The lampreys include 4 species; the sharks 18 species; the catfishes 11 species, of which 2 are marine; suckers 9 species; minnows or carps 39 species; herrings 10 species; salmon family, which includes the trout and whitefish, 20 species, one half of which number have been introduced; pikes 6 species; killy fishes 5 species; sticklebacks 5 species; silversides 5 species; the mackerel family 10 species; the pompano family 18 species; sunfishes 13 species; perches, including the darters, 17 species; sea basses 8 species; weakfish family 10 species; sculpins 8 species, equally divided between the fresh and salt waters; sea robins 5 species, one of which, the red gurnard, probably never occurred in our waters, though it has been assigned to New York; codfishes 12 species, one of them a permanent resident in fresh water; flounders 10 species, but one of these is of doubtful occurrence.

The species whose existence in New York waters has only recently been reported, and which are not numbered in this catalogue, are the bullhead minnow, *Cliola vigilax* Baird & Girard, the silver-jawed minnow, *Ericymba buccata* Cope, silver chub, *Hybopsis amblops* Rafinesque, and the northern darter, *Etheostoma boreale* Jordan. The first three of these species have been found in the western part of New York, and the northern darter has been recorded in the basin of St Lawrence river, from Montreal to Lake Ontario.

The names used in this catalogue are substantially those employed by Jordan and Evermann in bulletin 47, United States National Museum; and I am indebted to these authors for many of the descriptions of the genera. There are some departures, however, from the names employed in that bulletin, for reasons which appear to me satisfactory; for example, the name *Etrumeus sadina* is discarded for the round herring, and the specific name *teres* of De Kay is used in its stead, because Mitchill's type bore a close resemblance to the shad. It has a spot behind the gill cover, a wide and toothless mouth, a projecting lower jaw, and 15 anal rays. There is no probability that Mitchill had the round herring before him for this description.

The glut herring in my list is called Clupea cyanonotus Storer; Mitchill's name, aestivalis, appears to be a synonym of mediocris and mattowaca of the same author. Its relation to the hickory shad was long since pointed out by Dr Gill. Mitchill stated that the fish has seven or eight dark roundish spots extending in the direction of the lateral line. His figure shows a row of eight dark spots on the side extending to the end of the dorsal fin on the level of the eye.

The name Coregonus labradoricus, for the Labrador whitefish, is omitted because that species is identical with the common whitefish. The characters by which the Labrador whitefish were supposed to be distinguished are untenable, precisely the same characters being found in the whitefish and there being no other basis of separation.

The author has discovered that Kirtlandia laciniata Swain is identical with K. vagrans Goode & Bean.

The species Querimana gyrans is believed to be the young of Mugil trichodon Poey; and the genus Querimana was found to be the young state of Mugil.

The name Neomaenis blackfordi is retained for the red snapper for the reasons clearly given in the *19th Report of the Commissioners of Fisheries of New York*, 1890. There is absolutely no proof that the name aya should be applied to this species.

The synonymy given for the species is limited usually to authors who wrote specially on the fishes of New York, or adjacent regions, and to the well known general catalogues of recent writers on ichthyology. One principal aim has been to give as many references as possible to illustrations of species.

The descriptions of the fishes are based chiefly on collections studied by the author, many of which were obtained in his own field work. The results of investigations made by parties for the United States Fish Commission have also been incorporated in the text.

Illustrations of the species would have added greatly to the report; but the time was not available for obtaining drawings

for this purpose. Artificial keys also would have been an additional advantage; but, as references are given in every case to bulletins 16 and 47 of the United States National Museum, which contain complete series of artificial keys, this feature was omitted.

The author hopes ere long to prepare a new account of the fishes of New York, containing illustrations of all the species, together with keys for identification, but can not complete such an undertaking till after the inland waters of the state have been more thoroughly and systematically investigated.

TARLETON H. BEAN

Washington D. C. 1902

Class MARSIPOBRANCHII

Order HYPEROARTII

Family PETROMYZONTIDAE

Lampreys

Genus PETROMYZON (Artedi) Linnaeus

Lampreys with the supraoral lamina armed with two or three separate teeth, pointed, and close together, not forming a crescent-shaped plate; anterior lingual tooth with a median depression; buccal disk large, with numerous teeth arranged in concentric series; dorsal fins separate, the second joined to the caudal.

1 Petromyzon marinus Linnaeus

Great Sea Lamprey; Lamprey Eel

Petromyzon marinus LINNAEUS, Syst. Nat. ed. X, 230, 1758; MITCHILL, Trans. Lit. and Phil. Soc. N. Y. I, 461, 1815; GÜNTHER, Cat. Fish. Brit. Mus. VIII, 501, 1870; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 11, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 10, pl. I, fig. 3, 1896.

Petromyzon americanus LE SUEUR, Trans. Am. Phil. Soc. Phila. I, 383, 1818; DE KAY, N. Y. Fauna, Fishes, 379, pl. 66, fig. 216, 1842; STORER, Hist. Fish. Mass. 275, pl. XXXVIII, fig. 4, 1867.

Petromyzon appendix DE KAY, N. Y. Fauna, Fishes, 381, pl. 64, fig. 211, 1842 (young).

Body cylindric, eellike, stout, somewhat compressed behind. The mouth is terminal, subcircular in shape and suctorial. It is strongly armed with large conical teeth or cusps mounted on papillae, those of the inner series being bicuspid. Guarding the throat are crescent-shaped plates, bearing pectinate lingual teeth; a pair of these plates on either side and another pair below them. The mandibulary plate has seven cusps.

There are seven branchial apertures on each side of the head, the first not far behind the eye; the distance of the last opening from the tip of the snout is contained about five times in the total length. Eye rather small, covered by membrane. The first dorsal originates in about the middle of the length; it is little developed and well separated from the second dorsal which is confluent with the anal. The anal is very low and

only about half as long as the second dorsal. The vent is far back, opposite the origin of the second dorsal.

The specimen described, number 10654 in the U. S. National Museum collection, is 28 inches long.

The sea lamprey or lamprey eel inhabits the north Atlantic, ascending streams to spawn and sometimes becoming landlocked. In some interior waters of New York the landlocked form has received the name, unicolor, of De Kay. The species ranges southward on our coast to Virginia. In the Delaware, Susquehanna and their tributaries this is a common fish. Its larval form, which is blind and toothless, is extremely abundant in muddy sandflats near the mouths of small streams and is a very important bait for hook and line fishing.

The sea lamprey grows to a length of 3 feet. It is dark brown in color, mottled with black and white. In the breeding season in spring the males have a high fleshy ridge in front of the dorsal. The spawning is believed to take place in May or June. The eels cling to the rocks by means of their suctorial mouths and the eggs are deposited in shallow water on a rough bottom where the current is swift. Some observers state that they make nests by heaping up stones in a circle and deposit the eggs under the stones. The ovaries are large, but the eggs are very small.

The food of the lamprey is chiefly animal matter and the fish is somewhat of a parasite, burrowing into the side of shad, sturgeon and some other species. The teeth are adapted for this method of feeding. The tooth-bearing bone of the upper side of the mouth contains two teeth which are placed close together. On the bone corresponding with the lower jaw there are seven or nine stout cusps. There are numerous teeth around the disk, the first row on the side of the mouth containing bicuspid teeth; the others are simple. The tooth on the front of the tongue has a deep median groove. The species is adapted for fastening itself to other fishes and extracting from them their blood.

The lamprey is considered a good food fish in some localities, but in other places it is rarely eaten. In Connecticut and Massachusetts the species is highly esteemed. It is preserved by salting for several weeeks before using. The fish is sometimes caught with the hands or by means of a pole armed with a hook in the end. As it is found in shallow water and will not usually relinquish its hold on the bottom, its capture is easily effected.

The sea lamprey has been obtained in Gravesend bay in small numbers in March, April and June. It is not adapted to captivity because of the impracticability of furnishing it with proper food.

2 **Petromyzon marinus unicolor** (DeKay)

Lake Lamprey

Ammocœtes unicolor De Kay, N. Y. Fauna, Fishes, 383, pl. 79, fig. 250, 1842.
Petromyzon marinus subsp. *dorsatus* Wilder in Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 869, 1882.
Petromyzon marinus unicolor Meek, Ann. N. Y. Ac. Sci. 284, 1886; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 10, 1896.

De Kay described this lamprey under the name Ammocœtes unicolor in *Zoology of New York; or the New York Fauna*, pt 4, Fishes, p. 383, pl. 79, fig. 250. His description was made from a specimen 4 inches long and $\frac{5}{16}$ of an inch in depth. The plate represents it as having the dorsal scarcely perceptible, beginning to rise at about the middle of its length, but at no point exceeding $\frac{1}{16}$ of an inch in hight. The anal is similar to the dorsal and like the latter continuous with the caudal. Dr De Kay received specimens from the Rev. Zadock Thompson, who obtained them from Lake Champlain.

This variety is distinguished from the common marine lamprey only by its size, its uniform dark coloration, more pronounced dorsal ridge, and the less degree of separation of the dorsal fins. It inhabits the lakes of northern and central New York and is not anadromous.

Prof. Seth E. Meek has published in the *Annals of the New York Academy of Sciences* 4:299, the following notes on the species.

The lake lamprey is found in larger numbers than the brook lamprey, and reaches a much larger size.

During the spring of 1886 more than a thousand individuals were taken from Cayuga lake inlet, and all of them within 5 miles of Ithaca. They began to ascend the inlet to spawn on May 21, and continued to do so until late in June.

Their nests are excavations made in the bed of the stream, in shallow water, usually just above ripples. The eggs are deposited in the fine sand and gravel at the bottom of these nests, and the embryos developed there. The larvae live in the sand along the edge of the stream just below the water line. This species is parasitic on bullheads, suckers, and other large, soft-rayed fishes.

Of the whole number captured and brought to the university by fishermen within two weeks, 480 were males and 265 females.

The longest male specimen was 17 inches, and the shortest 9 inches. The longest female measured 14 inches, and the shortest 10 inches. A small female 7 inches long, taken later, contained eggs which were quite immature.

During the spring a crest is developed upon the back of the male between the nape and the dorsal fin. A smaller crest is developed upon the ventral surface of the female, between the vent and the caudal fin. This was at first supposed to be characteristic of the males of Cayuga lake, and was made the basis of a new specific name; but it has since been found in specimens from the Atlantic slope, and it is said by Seeley to occur in European specimens during the breeding season. This crest is seasonal and sexual. The sexes, at other seasons, can not be easily distinguished, if at all.

More recent accounts of this lamprey are those of Prof. H. A. Surface in the Bulletin U. S. Fish Commission for 1897 and the *4th annual Report of the Commissioners of Fisheries, Game and Forest of the State of New York.*

Genus ICHTHYOMYZON Girard

Differs from Petromyzon in having the anterior lingual tooth divided by a median groove and the dorsal fin notched, but not separated into two portions. Size small. Habitat, fresh waters of eastern United States.

3 Ichthyomyzon concolor (Kirtland)

Silver Lamprey

Ammocœtes concolor Kirtland, Bost. Jour. Nat. Hist. III, 473, 1840, with plate (larva).

Petromyzon concolor Jordan & Fordice, Ann. N. Y. Ac. Sci. 282, 1886.

Ichthyomyzon argenteus JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 10, 1882.

Ichthyomyzon concolor JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 11, 1896.

The silver lamprey belongs to the subgenus Ichthyomyzon of Girard. The tooth on the front of the tongue is divided in two parts by a median groove and the dorsal fin is continuous but deeply notched. The maxillary tooth is bicuspid: the teeth on the disk are in about four series and all small. The tooth-bearing bone of the lower part of the mouth has seven cusps. The head (from tip of disk to first gill opening) is two fifteenths of the total length: with the gill openings its length is contained four and three fourths times in the total. There are 51 muscular impressions from gills to vent. The body is rather stout, compressed posteriorly. The head is broad and the buccal disk large with its edges not conspicuously fringed. Color bluish silvery, sometimes with blackish mottlings. Above each gill opening there is a small bluish blotch.

The silver lamprey or mud eel is found in the Great lakes region and the Ohio and Mississippi valleys. It grows to a length of 12 inches and is usually found in deep water, but runs up the small streams to spawn in the spring. It is a troublesome parasite on the lake sturgeon, the paddlefish, yellow perch and some other species. It becomes fixed to the skin by means of its suctorial disk and the irritation of its teeth sometimes causes deep ulcers at the point of attachment. This lamprey has the same peculiarities of development as the sea lamprey and sometimes remains in the larval condition, blind and toothless, till it has reached a length of 8 inches.

Genus LAMPETRA Gray

Small lampreys inhabiting brooks of Europe and North America. The dorsal fin either notched or divided into two parts, the posterior part continuous with the anal around the tail: supraoral lamina broad, crescentic, with a large obtuse cusp at each end and sometimes a minute median cusp: lingual teeth small, with a crescentic toothed edge, the median denticle en

larged: buccal disk small, with few teeth which are never tricuspid.

The genus Lampetra is best distinguished from Petromyzon by the structure of its so called maxillary tooth, which has the form of a crescent-shaped plate with terminal cusps and, sometimes, an additional median cusp. In Petromyzon this bony plate is short and contains two or three teeth which are very closely placed.

4 Lampetra wilderi (Gage)

Small Black Lamprey; Pride

Lampetra wilderi Gage, in Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 13, 1896.

Petromyzon nigrum Rafinesque, Ich. Ohien. 84, 1820. (Name preoccupied).

Ammocœtes niger Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 9, 1882.

Ammocœtes branchialis Jordan & Fordice, Ann. N. Y. Ac. Sci. 293, 1886; Gage, in Wilder Quarter-Century Book, 436, 1893.

The high dorsal fin is divided into two parts by a deep notch. Several of the teeth on the side of the buccal disk are bicuspid and the rest simple. The mandibulary plate is nearly straight and has eight or 10 cusps of nearly equal size. The length of the head including the gills is contained four and three fourths times in the total. There are 67 muscular impressions from gills to vent. In the spring a prominent anal papilla is present. The head is larger than the space occupied by the gill openings and is contained eight and one third times in the total; the depth, 14 times. The eyes are large; the mouth moderately small. The lips are conspicuously fringed with papillae. The teeth change considerably with age; young examples have no median cusp on the maxillary plate.

This lamprey is bluish black above, the lower parts silvery.

The brook or mud lamprey, also known as the small black lamprey, is found in the Great lakes region, the Ohio valley and the upper Mississippi valley. It occurs also in Cayuga lake, New York. According to Jordan it ranges west to Minnesota and south to Kentucky. It grows to a length of 8 inches. Dr Jordan considers it identical with the common brook lamprey of Europe, A. branchialis.

This lamprey ascends the small streams in the spring to spawn just as the silver lamprey does. It is parasitic and its spawning habits are similar to those of the sea lamprey. It clings to stones and clods of earth while depositing its eggs and is believed by some persons to die after spawning. The probability is that it goes to deep water where it remains till the spawning season again approaches.

May 8, 1886, Prof. Gage and Dr Meek caught five specimens in Cayuga lake inlet. More of them were seen but not captured. May 22 they visited the inlet a second time but saw no specimens.

The five individuals obtained were all males, and all were busily engaged in building nests. They ascend the inlet to spawn about two weeks earlier than the large lake lamprey, and in smaller numbers.

The life history of the brook or small black lamprey is well related by Prof. Surface in the articles referred to in the notes on the lake lamprey.

Class PISCES

Subclass SELACHII

Sharks and Skates

Order ASTEROSPONDYLI

Typical Sharks

Family PSEUDOTRIAKIDAE

Genus PSEUDOTRIAKIS Capello

Body elongate; mouth wide, with a very short labial fold around the angle; snout depressed, rounded, moderately long; nostrils inferior, near the mouth, but not confluent with it; eyes oblong, lateral, without nictitating membrane; spiracles well developed behind the eye; gill openings moderate, in advance of the pectoral; jaws armed with numerous rows of small, tricuspid teeth; first dorsal fin, opposite the space between pectorals and ventrals, long and low, gradually increasing in hight posteriorly; second dorsal behind ventrals, opposite and similar to anal; ventrals and pectorals well developed; no pit at the root of caudal

fin, the basal lobe of which is very low and long; skin with minute asperities.

5 Pseudotriakis microdon Capello

Peixe Carago (Portugal)

Pseudotriakis microdon Capello, Jorn. Sci. Math. Phys. e nat. Lisboa, I, 321, pl. V, 1868; Günther, Cat. Fish. Brit. Mus., VIII, 395, 1870; Bean, Proc. U. S. Nat. Mus. VI, 147, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 27, pl. IV, fig. 14, 1896.

The greatest hight of the body is at the origin of the first dorsal; it is contained eight and three sevenths times in the total length. The hight at the origin of ventrals is contained nine and one half times in total length. The hight of head at the first gill opening is a little greater than that of body at the ventral origin, while its hight at the angle of the mouth is a little less than one eleventh of the total length. The least hight of the tail equals the hight of the anal, and is contained 25 times in total length.

The head is somewhat depressed in front, with moderately sharp snout, which is nearly twice as long as the distance of its tip from the mouth. The distance from snout to last gill opening is contained five times in total length. The distance from snout to first gill opening, measured horizontally, equals twice the hight of body at origin of second dorsal. The distance between the first and last gill openings equals nearly twice the length of the eye. The hight of the first gill opening is about equal to the distance between the angle of the mouth and the spiracle. The hight of the head at angle of mouth is contained 11 times and at the first gill opening nine times in total length. The length of the snout equals one half the body hight at origin of first dorsal. The distance of mouth from snout, measured on the axis of the fish, equals one third width of mouth. The distance from snout to angle of mouth, obliquely taken, equals one fourth the distance from snout to last gill opening. The distance between eye and spiracle equals that from mouth to nostril. The distance from angle of mouth to spiracle is about equal to hight of first gill opening. The spiracle is moderately

large, the length of its opening being contained twice in the hight of fourth gill opening. The oblong eye is placed near the dorsal profile; the length of the orbit is about one half the greatest hight of second dorsal; the length of the eye equals about one fourth width of mouth. The length of upper jaw is slightly more than that of lower, and nearly equals the distance between the spiracles. The distance from the mouth to the nostril is about one fourth least hight of tail; the distance between nostrils equals four times the distance from eye to spiracle. The interorbital space equals one half the length of second dorsal base. The distance between the spiracles equals four times their greatest length.

The first dorsal is very long and low, highest behind its middle, the length of its base equal to seven times its greatest hight; its distance from the snout is a little more than twice the greatest length of pectoral. The second dorsal is distant from the end of the first a length equal to nearly twice its greatest hight; the length of its base is somewhat more than the body hight at origin of first dorsal. The second dorsal begins at a distance from the end of the first, which is equal to the hight of body at ventral origin; the length of its base equals twice the interorbital distance; its hight equals nearly twice the length of the orbit. The anal is entirely under the second dorsal, but its base is a little less than five sevenths as long as that of the latter; the greatest hight of the anal equals the least hight of caudal peduncle.

The caudal originates at a distance from the end of the second dorsal about equal to the hight of the anal; it is divided by a notch into a short upper portion, whose length is very little more than the greatest hight of first dorsal, and a very low and long lower portion, the longest margin of which is nearly twice as long as the snout. The distance of the caudal from the end of anal base equals one fourth the length of second dorsal base.

The distance of pectoral from snout is contained five times in total length; the length of pectoral equals nearly twice the width of its base, and is a little more than one ninth of total length.

The greatest width of pectoral equals twice the hight of anal, and is contained $12\frac{1}{3}$ times in total length.

The origin of the ventral is slightly in advance of the end of first dorsal, and is behind the middle of total length a distance equal to the interorbital space. The length of ventral equals that of lower jaw. The width of ventral base equals that of pectoral base; the greatest width of ventral slightly exceeds its length.

Color. When received the margins of the fins were apparently faded; the original color was probably grayish brown with dark margins on all the fins except the first dorsal. Capello states that his example was chestnut brown.

Remarks. The gills and mouth were obstructed by sand. The only parasites discovered on the animal were a couple of isopods, one of which was found in the eye cavity.

MEASUREMENTS	Millimeters	Hundredths of length
Total length	2950	100
Body		
Hight at origin of first dorsal	350	12
Hight at origin of ventral	310	10.5
Hight at origin of second dorsal	210	7
Hight at end of ventral base	210	7
Least hight of caudal peduncle	118	4
Width at origin of first dorsal	250	8.5
Head		
Distance from tip of snout to first gill opening		
Horizontally	425	14.4
Obliquely	450	15.3
Distance from tip of snout to last gill opening	583	20
Distance from first gill opening to fifth	133	4.5
Distance from first gill opening to fourth	102	.....
Distance from first gill opening to third	62	.....
Distance from first gill opening to second	27	.....
Hight of first gill opening	75	.....
Hight of second gill opening	73	.....
Hight of third gill opening	72	.....
Hight of fourth gill opening	70	.....
Hight of fifth gill opening	68	.....
Hight at angle of mouth	265	9
Hight at first gill opening	325	11
Hight at base of pectoral	342	11.6

MEASUREMENTS	Millimeters	Hundredths of length
Distance from tip of snout to eye (horizontally).	176	6
Distance from tip of snout to mouth (horizontally)	90	3
Distance from tip of snout to mouth (obliquely).	147	5
Distance from tip of snout to angle of mouth (horizontally)	280	9.5
Distance from tip of snout to angle of mouth (obliquely)	305	10.3
Distance from tip of snout to spiracle (horizontally)	286	9.7
Greatest length of spiracle	56	2
Length of opening of spiracle	35	.....
Distance from eye to spiracle	31	.....
Distance from angle of mouth to spiracle	74	.....
Length of orbit	80	2.7
Length of eye	68	2.3
Width of mouth	270	9
Length of upper jaw to angle of mouth	219	7.4
Length of lower jaw to angle of mouth	215	7.3
Distance from mouth to nostril	30	.....
Distance between nostrils	125	4.2
Distance between eyes	182	6.2
Distance between eyes on cartilage	142	4.8
Distance between spiracles	226	7.7
First dorsal		
Distance from snout	1000	34
Length of base	670	22.7
Greatest hight	95	.....
Second dorsal		
Distance from end of first dorsal	310	10.5
Distance from snout	1980	67
Length of base	368	12.5
Greatest hight	158	5.4
Length of posterior margin	55	.....
Anal		
Distance from snout	2087	70.7
Length of base	250	8.5
Greatest hight	119	4
Length of anterior margin	233	.....
Length of posterior margin	47	.....
Caudal		
Distance from end of second dorsal	116	.....
Distance of tip from end of second dorsal	620	21
Greatest width	232	.....

MEASUREMENTS	Millimeters	Hundredths of length
Length of upper lobe	98	.....
Greatest width of upper lobe	117	.....
Distance of lower lobe from anal base	91	.....
Length of anterior margin of lower lobe	228	.....
Length of longest margin of lower lobe	345	.....
Pectoral		
Distance from snout	590	20
Greatest length	330	11.2
Width of base	169	5.7
Greatest width	240	8
Ventral		
Distance from snout	1655	56
Greatest length	215	7.3
Length of posterior margin (last ray)	108	.....
Width of base	170	5.7
Greatest width	222	7.5

Only two specimens of this shark have been recorded—the type described by Capello from the coast of Portugal, and an example about 9 feet, 8 inches long which came ashore in excellent condition at the Amagansett life-saving station on Long Island, Feb. 8, 1883. The latter specimen was forwarded to the U. S. National Museum, Washington D. C.

A figure of the species is published in *Oceanic Ichthyology*, pl. 5, fig. 17.

Family GALEIDAE

Requiem Sharks

Genus MUSTELUS Cuvier

Body slender, elongate; mouth small, crescent-shaped, with well developed labial folds at the angles, snout rather long and depressed; teeth in both jaws very blunt, small, rhombic, many-rowed, arranged like pavement; spiracles small, just behind the eyes; eye large, oblong; pectorals large; ventrals well developed; first dorsal large, not far behind pectorals, somewhat larger than second dorsal; anal opposite to and smaller than second dorsal; basal lobe of caudal little developed, the tail nearly straight; embryo without placental attachment to the uterus.

6 **Mustelus canis** (Mitchill)

Dog Shark; Smooth Dogfish

Squalus canis Mitchill, Trans. Lit. & Phil. Soc. N. Y. 1, 486, 1815.
Mustelus canis De Kay, N. Y. Fauna, Fishes, 355, pl. 64, fig. 209, 1842; Storer, Hist. Fish. Mass. 251, pl. XXXVII, fig. 2, 2*a*, 1867; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 20, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 29, 1896.

Body cylindric, elongate, tapering greatly from the dorsal fin to the tail; head flattened above, one fourth of total length without caudal; snout obtusely pointed, one third as long as the head. Hight of body equals one half length of head. Nostrils large, semilunar, midway between tip of snout and angle of mouth. Eye two fifths as long as the snout. Teeth in about 10 rows, smooth, flattened, the posterior edges of each tooth slightly elevated. Spiracles small, circular, near the lower posterior angle of the eye. Gill openings moderate, half length of snout, the last two over the base of the pectorals. Hight of dorsal fin, measured from middle of its base, slightly greater than depth of body. Length of pectoral equal to base of dorsal. End of ventral base midway between tip of snout and tip of caudal, the length of the fin scarcely one third length of head. Caudal fin as long as the head, its lower lobe short, blunt, about one third as long as the upper. Color ashen gray above, sometimes with pale spots, white beneath; outer edges of the dorsals and anal with a black margin, specially in young; iris greenish yellow. Length 3 feet.

This is known as the dogshark, smooth dogfish and houndfish. It is extremely common in the north Atlantic and is a source of great annoyance to anglers. The shark is not eaten but it is used in making fertilizers and oil is prepared from its liver. It occurs in Gravesend bay in August, September and October. In captivity it is restless and delicate, often coming to the surface of the water and struggling as if trying to escape. Its food consists of small crustaceans, seaweed, etc.

Genus **Galeocerdo** Müller & Henle

Body cylindric, elongate, tapering; mouth crescentic; teeth in both jaws large, oblique, coarsely serrate on both margins;

outer margin with a deep notch; spiracles present; the last two gill openings over the pectoral base; caudal fin with a pit at the root above and below; first dorsal fin above the space between pectorals and ventrals. Size large.

7 Galeocerdo tigrinus Müller & Henle

Tiger Shark: Leopard Shark

Galeocerdo tigrinus MÜLLER & HENLE, Plagiostomen, 59, pl. 23, 1838; GUNTHER, Cat. Fish. Brit. Mus. VIII, 378, 1870; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 21, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 32, 1896; SMITH, Bull. U. S. F. C. for 1897, 88, 1898.

The caudal fin forms about one third of the total length and exceeds the space between the dorsals; the second dorsal is in advance of the anal; upper jaw with a long labial fold; teeth $\frac{2}{2}\frac{5}{5}$. Color yellowish gray, whitish beneath, brown on the middle of the back and with numerous brown cross bands and spots on the sides; adults nearly uniform brown. Said to reach a length of 30 feet.

Tropical seas, occasionally found in summer northward to Cape Cod and to San Diego.

Dr H. M. Smith has published the following record of its occurrence near Woods Hole Mass. "Present every year in variable abundance, and caught in traps in Vineyard sound and Buzzards bay. The last species of shark to appear in this region, rarely coming before August. It remains until October. Usual length, 5 feet." The writer has seen a tiger shark fully 9 feet long in a trap at Marthas Vineyard.

Genus PRIONACE Cantor

Body and head slender; teeth in both jaws strongly serrated in adults, broad in the upper jaw, narrow, straight and claviform in the lower; spiracles absent; first dorsal large, its origin midway between axils of pectorals and ventrals; second dorsal much smaller than first, usually equal to anal; embryo without placental attachment to uterus; size large; inhabiting warm seas.

8 Prionace glauca (Linnaeus)

Great Blue Shark

Squalus glaucus Linnaeus, Syst. Nat. ed. X, 235, 1758.
Carcharias (Prionodon) glaucus Müller & Henle, Plagiostomen, 36, pl. II, 1838.
Carcharias glaucus Günther, Cat. Fish. Brit. Mus. VIII, 364, 1870.
Carcharhinus glaucus Jordan & Gilbert, Bull. 16, U.S. Nat. Mus. 22, 1883.
Prionace glauca Jordan & Evermann, Bull. 47, U. S. Nat. Mus., 33, pl. IV, fig. 16; pl. V, fig. 16*a*, 1896; Smith, Bull. U. S. F. C. for 1897, 88, 1898.

Snout very long; nostrils rather nearer to the mouth than to the tip of snout; a slight groove at the angle of the mouth; teeth of the upper jaw oblique, slightly constricted near the base; lower teeth narrow, lanceolate, with a broad base in the adult, triangular in the young. Pectoral fin long, falciform, extending to below the dorsal. Color light bluish gray above, paler below.

The great blue shark is common in the Mediterranean and is found occasionally on our Atlantic and Pacific coasts.

Dr H. M. Smith records it as a very rare species at Woods Hole Mass., only a single individual being certainly known from that locality, taken from a trap in July 1877.

Genus CARCHARHINUS Blainville

Body rather robust, the head broad and depressed: mouth inferior, with the teeth in both jaws strongly serrated in the adult, less so or entire in the young; those in the upper jaw broad or narrow, those below narrow, straight, and nearly erect. No spiracles. First dorsal large, placed not far behind pectorals; pectorals falcate; second dorsal small. Embryos attached by placenta to the uterus.

9 Carcharhinus obscurus (Le Sueur)

Dusky Shark

Squalus obscurus Le Sueur, Jour. Ac. Nat. Sci. Phila. I, 223, pl. 9, 1818.
Carcharias (Prionodon) obscurus Müller & Henle, Plagiostomen, 46, 1841.
Carcharias obscurus De Kay, N. Y. Fauna, Fishes, 350, pl. 61, fig. 201, 1842. (Copy of Le Sueur); Storer, Hist. Fish. Mass. 243, pl. XXXVI, fig. 2, 1867; Günther, Cat. Fish. Brit. Mus. VIII, 366, 1870.
Carcharhinus obscurus Jordan & Gilbert, Bull. 16, U.S. Nat. Mus. 22, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 35, 1896; Smith, Bull. U. S. F. C. for 1897, 88, 1898.

Head broad, somewhat pointed, flattened above and below; snout sharp edged, rounded and wide at the end; eyes large,

nearly circular; nostrils oblique, near the tip of the snout; gill-openings unequal, the first large, the last small and over the origin of the pectoral; the second dorsal smaller than the anal, and much produced behind; pectorals very long, narrow, falciform, their outer margin four times the inner. Color dusky above, dark clear blue in young, white below. Size large, length 9 or 10 feet.

The dusky shark inhabits the middle Atlantic and occurs frequently on our coast in summer. Abundant in Great Egg bay where it is called the "man-eating shark." A specimen weighing 150 pounds was reported there July 23, and during the same week a larger one weighing 200 pounds was landed. Young individuals measuring 21½ to 24 inches in length, caught with hooks July 29, 1887, still bore the umbilical scar. A young example was caught in a pound at Islip L. I. in the summer of 1898.

De Kay had no specimen of the dusky shark for examination, but depended on Le Sueur for the description and figure published in his *New York Fauna*. Mitchill has made no reference to the species.

Smith publishes the following on its occurrence at Woods Hole Mass. "Very common, but less so than the sand shark. Taken in traps and on lines fished from wharves. Comes about June 1 and remains through a part of November. The largest observed here are 12 to 14 feet long; the average are 8 or 9 feet, and the smallest are 2½ feet." Storer says it is not a common species in Massachusetts waters; it sometimes floats ashore in the night or becomes entangled in the mackerel nets.

The dusky shark feeds chiefly on menhaden when they are schooling.

10 Carcharhinus milberti (Müller & Henle)

Milbert's Shark

Carcharias (Prionodon) milberti Valenciennes in Müller & Henle, Plagiostomen, 38, pl. 19, fig. 3 (teeth), 1842.

Carcharias caeruleus De Kay, N. Y. Fauna, Fishes, 349, pl. 61, fig. 200, 1842; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 873, 1883.

Eulamia milberti Gill, Proc. Ac. Nat. Sci. Phila. 262, 1864.

Carcharhinus milberti JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 37, 1896; SMITH, Bull. U. S. F. C. for 1897, 88, 1898.
Small blue shark MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 487, 1815.
Lamna caudata DE KAY, N. Y. Fauna, Fishes, 354, pl. 62, fig. 205, 1842.

Body stout, its depth one fifth of the length without caudal; head two sevenths of total length to caudal base, snout prominent, pointed, broad, thin, and firm, its length from mouth equal to width of mouth; distance between nostrils two thirds length of snout; upper teeth very broad, triangular, erect, serrate on both edges, without notch; lower teeth narrower and more finely serrated; gill openings comparatively narrow; first dorsal begins close behind origin of pectoral, its hight somewhat greater than its base and equals one half interspace between dorsals; second dorsal very small, its base one fifth interspace between dorsals; caudal moderate, its length contained two and two thirds times in length of body, its lower lobe less than one half as long as the upper; pectorals rather small, not falcate, the length contained three and one half times in total length without caudal.

The young are slate blue on the upper parts, the same color but less pronounced on the sides, and the lower parts whitish; adults are uniform bluish gray above, lighter on the sides of head and body, white beneath, the iris greenish blue. Some examples taken at Woods Hole Mass. in 1873, were said to be of an intense almost indigo blue.

The blue shark occurs along our east coast in summer from Cape Cod to Florida. Young examples are not uncommon in the waters of New York. An example taken at Brenton's reef, on the coast of Rhode Island, measured 7 feet, 4 inches and weighed 161 pounds.

Mitchill states that it is often taken by nets in New York waters, as it commonly bites off the line when hooked. Individuals seen by him were 4 or 5 feet long. De Kay refers to this shark a second time under the name long-tailed porbeagle, of which he saw several young from New York harbor and an adult from Brenton's reef, on the coast of Rhode Island.

This shark was reported at Woods Hole Mass., in 1871 by Prof. Baird. Dr Smith records four examples, each about 4 feet long, from a trap near Woods Hole, Aug. 8, 1873, since which time none have been observed.

The species feeds chiefly on fish.

Genus APRIONODON Gill

Snout conical, more or less produced; teeth not serrated, narrow, on a broad base, erect in both jaws or sometimes slightly oblique in the upper; dorsal over the interspace between pectorals and ventrals.

11 Aprionodon isodon (Val. in Müller & Henle)

Tiburon

Carcharias isodon VALENCIENNES in MÜLLER & HENLE, Plagiostomen, 32, 1841.

Carcharias (Aprionodon) isodon DUMÉRIL, Elasmobranches, 349, 1870.

Aprionodon punctatus JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 24, 1883.

Carcharias punctatus GÜNTHER, Cat. Fish. Brit. Mus. VIII, 361, 1870.

Aprionodon isodon POEY, Enum. Pisc. Cubens. 200, 1875; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 42, 1896.

Snout short, compressed, and rounded; nostril one third of the distance from tip of snout to angle of mouth, nearly as large as the eye; the distance between the nostrils equals that from tip of snout to mouth; teeth in upper jaw small, on a broad base, without serrations, those of lower jaw similar but smaller, a small median tooth as usual; number of teeth $\frac{13}{13}$; first dorsal much higher and longer than the second and is separated from the last gill opening by a space equal to two thirds the length of its base; pectorals reach to below end of first dorsal; caudal pit very apparent, specially below; scales rounded posteriorly, with five keels; color above dark gray (greenish brown, Duméril), whitish below.

The species is recorded from New York, Virginia, and Cuba. The type specimen in the Musée d'Histoire Naturelle, Paris, is 0.65m = 25⅝ inches long. The following measurements from the type are given by Müller and Henle.

	Inches	Lines
From tip of snout to nostril	.....	10
From nostril to mouth	.....	10
From mouth to anus	10	6
From anus to anal fin	2	6
Base of anal fin	1	.....
Hight of anal fin	1	.....
From anal fin to caudal	1	9
Length of caudal fin	-	.....
Distance from pectoral to ventral	4	6
Base of first dorsal fin	2	3
Hight of first dorsal fin	2	5
Base of second dorsal fin	1	.....
Hight of second dorsal fin	.....	7
Length of pectoral fin	3	4
Width of pectoral fin	2	4
Distance between nostriis	1	6
Width of mouth	2	.....

Genus SCOLIODON Müller & Henle

Body slender; snout depressed; no spiracles; teeth entire or little serrated, oblique and flat, the points directed sidewise so that the inner margins are more or less nearly horizontal, the teeth in front more nearly erect; teeth not swollen at the base, each of them with a deep notch on the outer margin below the sharp point; labial folds conspicuous; first dorsal over the interspace between pectorals and ventrals; second dorsal very small; ventrals small; size small.

12 Scoliodon terrae novae (Richardson)

Sharp-nosed Shark

Squalus (Carcharias) terrae-novae RICHARDSON, Fauna Bor.-Amer. 289, 1836.
Carcharias terrae-novae GÜNTHER, Cat. Fish. Brit. Mus. VIII, 360, 1870.
Carcharias (Scoliodon) terrae-novae GILL, Cat. Fish. East Coast N. A. 59, 1861.
Squalus punctatus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 483, 1815.
Scoliodon terrae-novae JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 24, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 43, 1896.

Snout moderately rounded; mouth U-shaped, with a short labial groove at its angle extending on both jaws; distance from tip of snout to nostril less than distance between nostrils; gill openings narrow; first dorsal moderate, midway between pec-

torals and ventrals; second dorsal very small, slightly behind, and rather smaller than anal; anal fin much shorter than distance from anal to ventrals; pectorals rather large, reaching about to middle of first dorsal; ventrals small.

Color gray; caudal fin with a narrow blackish edge. Cape Cod to Brazil, very common on the southern Atlantic coast.

The green-backed shark, *Squalus punctatus*, of Mitchill is said to belong to this species. His example was 31 inches long, but he was incorrectly informed that the shark reaches two or three times that size. Mitchill wrote:

"When this shark is in the water his back and sides appear greenish. But soon after his exposure to air, and immediately after his death, the hue becomes a pale ash, leaden, or dove, with but trifling variegations. The parts about the mouth, neck, and belly are of a clear white. The upper side of the pectoral fins resembles the color of the back; the lower partakes of the complexion of the belly. The openings of the excretory ducts on the snout and lips are blackish.

"The shark is very common on the coast of our southern states; it reaches the length of 3 feet."

Family SPHYRNIDAE

Hammerheaded Sharks

Genus SPHYRNA Rafinesque

Head laterally extended, hammer-shaped or kidney-shaped, the eyes on the ends of the "hammer" and the nostrils anterior; mouth inferior, crescentic; teeth in the jaws similar, oblique, notched on the outside near the base; no spiracles; last gill-opening over the pectoral; first dorsal large, nearer pectorals than ventrals; second dorsal and anal small; pectorals large; a pit at the root of the caudal; caudal fin notched near its tip, its lower lobe developed.

13 Sphyrna tiburo (Linnaeus)

Shorehead Shark; Bonnethead

Squalus tiburo LINNAEUS, Syst. Nat. ed. X, 234, 1758.

Zygaena tiburo GÜNTHER, Cat. Fish. Brit. Mus. VIII, 382, 1870.

Reniceps tiburo GILL, Ann. N. Y. Lyc. Nat. Hist. VIII, 412, 1861; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 25, 1883.

Sphyrna tiburo JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 44, pl. V, fig. 19, 1896.

Body slender and little compressed; head flat, semicircular in front, posterior margins of "hammer" short, free, the lateral margins continuous with the anterior; first dorsal high, midway between pectorals and ventrals; second dorsal much smaller, produced behind, higher and shorter than anal; ventral and caudal fins moderate; pectorals large; mouth small; teeth small, very oblique, deeply notched on the outer margin. Head one sixth of total length to tip of caudal, slightly longer than wide.

Color uniform ashy, whitish beneath. Length 5 feet. Atlantic and Pacific oceans, occurring on our coast from Long Island southward.

Neither Mitchill nor De Kay mentions the shovelhead shark, though both record the hammerhead. Prof. Baird found it a common fish in Great Egg bay in 1854, but the species was not seen there by the writer in 1887.

14 Sphyrna zygaena (Linnaeus)

Hammerhead Shark

Squalus zygaena Linnaeus, Syst. Nat. ed. X. 234, 1758; Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 482, 1815.

Zygaena malleus De Kay, N. Y. Fauna, Fishes, 362, pl. 64, fig. 204, 1842; Storer, Hist. Fish. Mass. 262, pl. XXXVIII, fig. 3, 1867.

Sphyrna zygaena Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 26, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 45, 1896; Smith, Bull. U. S. F. C. XVII, 88, 1898.

Body elongate, cylindric; head hammer-shaped, its width two or three times its length; nostril near eye, prolonged into a groove which runs along nearly the entire front margin of the head; eye large, placed near the angle formed by the anterior and lateral margins of the "hammer", enabling the animal to look above and beneath; three rows of white, hyaline teeth in each jaw, those in upper jaw entire, acute, triangular, their tips directed outward from the center, with a shoulder on the outer side; in the center a few with shoulders on both sides; gill openings short and small, the last smallest and placed over the pectoral base; first dorsal large, quadrilateral, slightly behind pectorals, higher than wide, deeply concave behind, and pointed

posteriorly; second dorsal rhomboidal, very small, produced posteriorly, its base extending farther backward than the anal base; pectorals placed low, subtriangular, broad, slightly concave behind; ventrals small, broad, nearly midway between the dorsal fins, produced behind; anal similar to second dorsal but somewhat larger, more concave behind; caudal equal in length to width of head, its lower lobe short, the upper ending in a small triangular portion; color uniform dusky gray, paler beneath.

The hammerhead shark reaches a length of 15 feet; it is a voracious species, found in all warm seas. Mitchill records the capture of three individuals in a net at Sag Harbor, in September 1805, the largest measuring 11 feet; and on opening its belly many detached parts of a man, together with his clothing, were found in it. He had a specimen from the bay of New York. De Kay had a specimen 25 inches long which was taken in a seine in New York harbor and he saw examples 4 feet long in Hell Gate. Dr Smith publishes the following about its occurrence at Woods Hole:

Usually common; some years abundant. Taken in traps from July to October, being most numerous in July and August. Generally swims with its dorsal and caudal fins out of the water. The largest ones taken here are 7 or 8 feet long; the smallest are under 1½ feet; and the average are 4 feet. The name "rakehead" is an old local designation of this species.

In Great Egg Harbor bay, N. J., small examples, measuring about 2 feet or less, are occasionally caught with hooks in August and larger ones, 5 or 6 feet long, have been seen. It is called "shovelnose shark" there. This shark is not common in Gravesend bay, but is sometimes found in August and September.

Family ALOPIIDAE

Thresher Sharks

Genus ALOPIAS Rafinesque

Body fusiform, moderately elongate, the snout short and blunt; mouth horseshoe-shaped; teeth distant, flat, triangular, entire, the third tooth of upper jaw on each side much the smallest; gill openings moderate, the last smallest and placed just

anterior to or slightly over the pectoral base; no nictitating membrane; spiracles minute, just behind the eye, or absent, first dorsal high, triangular, midway between pectorals and ventrals; second dorsal and anal very small; pectorals long and wide, deeply concave behind; ventrals wider than high, below the interspace between the dorsals; caudal without keel, exceedingly long and narrow, its lower lobe moderate, its upper lobe with a deep pit at its root and a notch near its tip; size large; a single species inhabiting most warm seas, and easily known by its long tail.

15 **Alopias vulpes** (Gmelin)

Thresher Shark; Swingle-tail Shark

Squalus vulpes Gmelin, L. Syst. Nat. I, 1496, 1788 (*fide* Günther); Mitchill, Trans. Lit. and Phil. Soc. N. Y. I, 482, 1815.

Carcharias vulpes De Kay, N. Y. Fauna, Fishes, 348, pl. LXI, fig. 199, 1842; Storer, Hist. Fish. Mass. 245, pl. XXXVI, fig. 3, 1867.

Alopecias vulpes Günther, Cat. Fish. Brit. Mus. VIII, 393, 1870.

Alopias vulpes Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 27, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 45, pl. VI, fig. 20, 1896; Smith, Bull. U. S. F. C. XVII, 89, 1898.

Body fusiform, moderately elongate, its greatest hight one fourth of the length to the pit at the root of the caudal; head two sevenths of the same length; eye one ninth as long as head; no nictitating membrane; snout short, twice as long as the eye, Flat, triangular teeth of moderate size, with entire edges, in both jaws, the third tooth of the upper jaw on each side much smaller than the others; spiracles just behind the eyes, minute or wanting; gill openings moderate, the last one over the base of the pectoral; first dorsal large, midway between pectorals and ventrals; second dorsal and anal very small; caudal elongate, slender, forming about one half of the total length; a pit at its base, upper lobe notched near the tip, lower lobe moderate; no caudal keel; ventrals one half as long as the pectorals; pectorals falcate, reaching to below the middle of the first dorsal.

The thresher shark is abundant in the Mediterranean and warm parts of the Atlantic and Pacific, occasionally seen off the south shore of Long Island in summer and frequently taken in Vineyard sound. It reaches a length of 20 feet.

Mitchill described, in the *Medical Repository*, 8:77, an individual measuring 13 feet and 1 inch, which was found, in 1803, on the south side of Long Island. De Kay describes the species but without mentioning any locality of its capture. His figure was based on a female specimen, about 13 feet long, in the American museum.

At Woods Hole Mass. the thresher comes in April and remains till late in the fall. It is common in Vineyard sound and is found also in Buzzards bay. In the fall the boat fishermen, fishing for cod at Gay Head, catch them with lines baited with fresh herring. Individuals 20 feet long have been caught at Menemsha.

The shark feeds on mackerel, menhaden, herring and other small fishes.

Family CARCHARIDAE

Sand Sharks

Genus CARCHARIAS Rafinesque

Body moderately elongate; the snout pointed; mouth large, crescentic; teeth long, narrow, awl-shaped, not serrated, most of them with one or two small basal cusps; spiracles minute, porelike; no nictitating membrane; gill openings in advance of the pectorals, moderately large; dorsal fins nearly equal, not large, the first well behind the pectorals; caudal well developed, without keel, its basal lobe short, a notch near its tip; pectorals short, not reaching to beginning of dorsal; size moderate.

16 Carcharias littoralis (Mitchill)

Sand Shark

Squalus littoralis MITCHILL, Am. Month. Mag. II, 328, 1818; LE SUEUR, Jour. Ac. Nat. Sci. Phila. I, 224.

Carcharias littoralis DE KAY, N. Y. Fauna, Fishes, 351, 1842; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 46, 1896; SMITH, Bull. U. S. F. C. XVII, 89, 1898.

Eugomphodus littoralis GILL, Proc. Ac. Nat. Sci. Phila. 209, 1864.

Odontaspis americanus GUNTHER, Cat. Fish. Brit. Mus. VIII, 392, 1870.

Carcharias americanus JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 27, 1883.

Body moderately elongate, its greatest hight contained five to six and one half times in the total length; head moderately

pointed, its length nearly one fourth of the total in half grown individuals; eye small, longer than deep, its length one fifth that of the snout, which is nearly one fourth as long as the head. The spiracle is located behind the eye at a distance equal to three times the diameter of the eye. Two rows of teeth in function in upper jaw and three rows in lower; longest tooth of the lower jaw as long as the eye, slightly longer than the longest tooth of the upper jaw; teeth long, awl shaped, mostly with one or two small cusps at the base, the first and fourth of upper jaw and the first of lower jaw without cusps. Space occupied by gill openings equals one fourth of the length of the head; the depth of the gill openings equals four times the length of the eye. The distance from the snout to the nostril equals the distance between the nostrils. The width of the mouth, including the labial folds, equals two fifths of the length of the head. The first dorsal base is entirely within the first half of the total length; it is about one third as long as the head, and somewhat exceeds the hight of the fin. The pectoral is one half as long as the head and, when extended, does not quite reach the vertical through the dorsal origin. The ventral origin is slightly behind the end of the first dorsal base; the length of the fin is nearly one third of that of the head. The caudal, measured from the pit at its root, forms two sevenths of the total length.

This small but voracious shark is common on our Atlantic coast, specially from Cape Cod to Cape Hatteras. It preys on the smaller fishes. The last individual observed by me in Great South bay during the summer of 1898 was swimming close to the surface near the inlet at Fire Island, September 16.

Mitchill described this shark under the name of the ground shark (Squalus littoralis) in the *American Monthly Magazine* for March 1818, p. 328. His specimen was caught in a set net near New York city, and measured about 5 feet. He mentions a larger individual, 8 feet 9 inches long, which weighed upward of 150 pounds. The fishermen called the fish ground shark because it is usually found along shores, or within soundings.

According to Dr Smith this is the commonest shark of the Woods Hole region; it is found in Vineyard sound from June to November. The largest are 12 feet long. Fish, crabs and other animals are found in its stomach.

Some of the teeth of a large individual were secured from A. P. Latto at Southampton in July. Instead of a single basal cusp, as usual, certain teeth had two such cusps on each side. The last sand shark seen by me during the summer of 1898, in Great South bay, was observed September 16 near the inlet at Fire island, swimming slowly westward near the surface. A list of specimens follows.

(Teeth)	Southampton, Atlantic ocean	July
♂	Clam Pond cove, Great South bay	Sep. 6
♀	Clam Pond cove, Great South bay	Sep. 6

A young male received from Gravesend bay June 26, 1895, lived in captivity till Dec. 19, 1895, when the temperature of the water in its pool was 53° F. The following notes were made from the recently dead specimen:

Color, bronze gray with light brown blotches, the largest about as long as the eye; belly and other lower parts white; eye yellowish; tips of pectorals, ventrals, dorsals, anal and caudal above and below with a narrow black streak; numerous minute dark specks on the under surface of snout and suborbital region, extending back to angle of mouth.

Two rows of teeth in function above and three below. Length of longest tooth in lower jaw, one half inch; in upper jaw, three eighths inch.

MEASUREMENTS

	Feet	Inches
Length	3	6
Depth of body	....	6½
Least depth of caudal peduncle	....	1⅝
Tip of snout to perpendicular through last gill opening	....	10
From first to last gill opening	....	2½
Depth of gill openings	....	2
Snout	....	2½
Eye to spiracle	....	1½
Eye	½ long	⅜ deep
Snout to nostril	....	1¼

MEASUREMENTS

	Feet	Inches
Width of nostril	....	5/8
Distance between nostrils	....	1¼
Nostril to front of mouth	....	½
Length of mouth opening	....	2⅝
Width of mouth, including labial folds	....	4
Length of labial fold	....	1
Labial fold to first gill opening	....	3¾
Snout to first dorsal	....	16
First dorsal base	....	3½
Middle of dorsal base to top of fin	....	3
Length of posterior margin of dorsal	....	1¼
From first to second dorsal	....	5
Length of second dorsal base	....	2¾
Middle of second dorsal base to top of fin	....	2½
Posterior margin of second dorsal	....	1⅛
Second dorsal to caudal pit	....	3
Caudal from pit	....	12
Lower caudal lobe	....	9⅜
Terminal caudal lobe	....	3
Snout to pectoral, obliquely	....	10¾
Length of pectoral	....	5
Lower margin of pectoral	....	2¼
Extended pectoral not quite reaching to perpendicular through front of dorsal.		
Ventral origin slightly behind end of first dorsal base		
Length of ventral	....	3⅛
Inner margin of ventral	....	1¾
Vent to tip of clasper	....	1½
End of ventral base to origin of anal	....	3¾
Anal base	....	3
Hind margin of anal	....	1
Depth of anal	....	2
Anal base to origin of lower caudal lobe	....	1¾

Family LAMNIDAE

Mackerel Sharks

Genus ISURUS Rafinesque

Body fusiform, stout; mouth wide, with long, sharp edged, lanceolate, entire teeth having no basal cusps; spiracles minute or absent; gill openings wide, all in advance of pectorals, lateral, not extending under the throat; first dorsal large, not far behind origin of pectoral; second dorsal and anal very small; pec-

torals large; ventrals moderate; tail slender; a pit at the root of the caudal; the caudal peduncle strongly keeled on each side; caudal fin lunate, its two lobes nearly equal. Size large.

17 Isurus dekayi (Gill)

Mackerel Shark

Lamna punctata De Kay, N. Y. Fauna, Fishes, 352, pl. 63, figs. 206, 207, 1842 (not *Squalus punctatus* Mitchill; Storer, Hist. Fish. Mass. 249, pl. XXXVII, fig. 1, 1867. This is probably *Lamna cornubica*).

Isuropsis dekayi Gill, Ann. N. Y. Lyc. Nat. Hist. 153, 1861.

Isurus dekayi Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 874, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 48, pl. VI, fig. 21, 1896.

Body fusiform, cylindric, its greatest depth equaling one fifth of the total length, and slightly exceeding the length of the head. The caudal lobes are nearly equal in length, the upper about equal to depth of body. Gill openings wide, the last over the anterior edge of the pectoral base; middle teeth very long, much longer and narrower than the crowded, triangular lateral teeth; first dorsal inserted behind pectorals at a distance equal to one fourth of length of head; falcate, its base equal to one third of its distance from tip of snout, its hight nearly one eighth of the total length; pectoral falcate, more than one fifth of total length, and longer than upper caudal lobe; anal and second dorsal small; caudal keel nearly one fifth of total length; deep pits at the root of the caudal above and below.

Color dark slate, lighter beneath. De Kay was informed that it is of a deep bottle green in life and the tongue is mottled with black. Storer states that all the upper part of the body is greenish, which becomes of a slate color after death; pupils black; iris dusky.

The mackerel shark reaches the length of 10 feet. It occurs from Cape Cod to the West Indies; but is rarely captured in most localities.

De Kay described a specimen 10 feet 2 inches long, taken in New York harbor, October 1840. A somewhat smaller example was caught near the light-ship off Sandy Hook by Capt. C. H. Barnard 16 years earlier than the date of De Kay's description. Storer refers to it as the most common species of shark found in

Massachusetts, which is not the case at present. In 1845 about 150 at least were captured in nets at Monhegan Me. during three weeks of mackerel fishing.

The fish was valued for its oil, of which 11½ gallons have been taken from a single liver.

This species feeds on many kinds of fish, but persistently follows the mackerel schools, and is generally known as the mackerel shark. At Provincetown it is called the blue shark.

Genus LAMNA Cuvier

Body short, stout, the back considerably elevated; snout prominent, pointed; teeth entire, pointed, triangular, with a small basal cusp on each side, one or both cusps sometimes wanting on some teeth in the young; gill openings wide, and all of them in advance of the pectoral fin; first dorsal falcate, inserted over the axil of the pectoral; second dorsal and anal very small, nearly opposite each other; pectorals falcate; caudal peduncle strongly keeled on each side; deep pits at the root of the caudal above and below; caudal lobes nearly equal in length. Size large.

18 Lamna cornubica (Gmelin)

Porbeagle

Squalus cornubicus GMELIN, L. Syst. Nat. I, 1497, 1788.
Lamna cornubica GÜNTHER, Cat. Fish. Brit. Mus. VIII, 389, 1870; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 30, 1883; BEAN, Bull. U. S. F. C. IX, 198, pl. LVII, 1891; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 49, pl. VI, fig. 22, 1896.

Body short, stout, fusiform, its greatest depth equaling nearly one fifth of the total length including caudal, and slightly less than the length of the head. The caudal lobes are nearly equal in length, the upper as long as the head and exceeding depth of body; caudal peduncle strongly keeled on each side; deep pits at the root of the caudal above and below. The snout is conical, pointed, its length somewhat more than the width of the mouth. Teeth entire, triangular, pointed, with a basal cusp on each side, the cusp sometimes wanting in young, $\frac{1}{1}\frac{2}{1}$ or $\frac{1}{1}\frac{1}{0}$ on each side in an individual about 3½ feet long, the third tooth of the upper

jaw on each side small; gill openings wide and all of them in advance of the pectoral base; first dorsal falcate, inserted over the axil of the pectoral; second dorsal and anal very small, nearly opposite each other; pectoral falcate, its length nearly equal to greatest depth of body and equals distance from angle of mouth to last gill opening.

Color dark slate, whitish beneath. Found in the Atlantic and Pacific, north to Massachusetts bay and the Gulf of Alaska; called salmon shark at Kadiak. Reaches a length of 10 feet.

The porbeagle, salmon shark, or mackerel shark is a very powerful and destructive species, and it has a wide distribution. If the figure of Lamna punctata Storer be correct, his mackerel shark must be Lamna cornubica and not Isurus dekayi. The advanced position of the first dorsal seems to indicate this.

Genus CARCHARODON Smith

Agrees with Isurus and Lamna except in dentition; teeth large, flat, erect, triangular, serrate; first dorsal moderate, nearly midway between pectorals and ventrals; second dorsal and anal very small; pectorals large; ventrals moderate; caudal peduncle stout; caudal lobes large and strong; deep pits at the base of the caudal fin above and below.

19 Carcharodon carcharias (Linnaeus)

Great White Shark; Man-eater

Squalus carcharias LINNAEUS, Syst. Nat. ed. X, 235, 1758.

Carcharias atwoodi STORER, Proc. Bost. Soc. Nat. Hist. III, 72, 1848; Hist. Fish. Mass. 246, pl. XXXVI, fig. 4, 1867.

Carcharodon carcharias JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 875, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 50, 1896.

Body stout, its greatest depth contained about five or five and one half times in the total length, and equaling about three fourths of the length of the head; eye perpendicularly oblong, and about one third as long as the snout; caudal lobes large and strong, nearly equal in length, the upper about six sevenths of depth of body; caudal peduncle stout, strongly keeled, its least depth two thirds of snout, deep pits at the base of the caudal

fin above and below; the snout obtusely pointed, about one fifth to one sixth of length of head; mouth very large; both jaws with large, triangular, serrated teeth in five rows, those in the lower jaw narrower, about 24 in each row above and 22 below; spiracles minute or wanting; gill openings wide and all in advance of the pectoral fin; first dorsal moderately large, inserted nearly midway between pectoral and ventral bases; second dorsal and anal very small, subequal, their bases scarcely more than one half as long as the snout; pectoral large, reaching to below the end of the dorsal when extended, ventral moderate, its length equal to nearly one fourth of that of the head. Color leaden gray, lower parts white; tips and edges of pectoral black. This shark reaches a length of 30 feet and a weight of nearly 2 tons. It is found in the temperate and tropical parts of the Atlantic and Pacific oceans, but is rare in New York waters.

The ferocity of the man-eater shark may be inferred from the following account of a specimen 13 feet long taken at Provincetown Mass. and brought to Boston for exhibition.

> My specimen was captured at Provincetown June 16 . . . When first seen it was swimming in about 10 feet of water on the Long point side of Provincetown harbor. A boat's crew having given chase, a harpoon was thrown into it, when it instantly turned toward the boat and seized it with great ferocity near the bows, in which act several of its teeth were broken off. It was eventually killed by being frequently lanced.

Jordan and Evermann record an individual about 30 feet long, caught near Soquel Cal. which had in its stomach a young sea lion weighing about 100 pounds.

Family CETORHINIDAE

Basking Sharks

Genus CETORHINUS Blainville

Body stout, the skin much wrinkled and beset with small spines; snout blunt; head small; mouth moderate, with numerous small, conical teeth without cusps or serrations; spiracles minute, above the corners of the mouth; gill openings very wide

extending from the back almost around the throat, all of them in advance of the pectorals; first dorsal large, midway between pectorals and ventrals; second dorsal and anal small; caudal fin lunate, the upper lobe considerably the larger; caudal peduncle keeled; pectorals and ventrals large. Brain very small. Size very large.

20 Cetorhinus maximus (Gunner)

Basking Shark; Elephant Shark

Squalus maximus Gunner, Trondhj. Selsk. Skrift., III, 33, tab. 2; IV, 14, tab. 3, 1765; Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 486, 1815.

Selachus maximus De Kay, N. Y. Fauna, Fishes, p. 357, pl. 63, fig. 208 (partly copied from Le Sueur), 1842; Storer, Hist. Fish. Mass. 253, pl. XXXVII, fig. 3, 1867.

Cetorhinus maximus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 31, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 51, pl. VII, fig. 23, 1896.

Body very stout, the skin wrinkled, rough, beset with small spines, its greatest depth contained about five times in the total length, and equaling about three fourths of the length of the head; caudal fin lunate, the upper lobe the larger, about equal to the depth of body; caudal peduncle keeled; snout smooth, blunt, nearly half the length of head; mouth moderate; the teeth very small and numerous, conical, without cusps or serratures, each jaw with six or seven rows, about 200 in each row; spiracles minute, above the corners of the mouth; eye very small, without nictitating membrane; gill openings very wide, extending from the back almost around the throat, all of them in front of the pectorals; gill rakers slender, long and close set, resembling whalebone, whence the name, bone shark; first dorsal large, triangular, midway between pectorals and ventrals; second dorsal small, but larger than the anal; pectoral large, reaching a little past the dorsal origin when extended; ventral large, its length nearly one third the length of the head. Color dark slate or leaden above, lighter beneath.

The basking shark reaches a length of nearly 40 feet and is the largest of the sharks. It is an inhabitant of Arctic seas, coming southward as far as Portugal, Virginia and California.

Mitchill refers to its capture at Provincetown Mass. and to its name of bone shark because of the peculiar structure of its gills. De Kay mentions the specimen which was captured in the lower harbor of New York in 1822, from which he made some alterations in a drawing partly copied from Le Sueur's sketch of the same fish. Storer described an individual measuring 33 feet 3 inches. He says it is rarely observed on the coast of Massachusetts. It becomes gregarious only in the breeding season.

The oil made from the liver of the basking shark was at one time considered valuable.

Order CYCLOSPONDYLI

Suborder CYCLOSPONDYLI

Family SQUALIDAE

Dogfishes

Genus SQUALUS (Artedi) Linnaeus

Body slender, elongate; mouth slightly arched, with a long, straight, deep, oblique groove on each side, without labial folds; teeth small, simple, equal in both jaws, their points turned aside so that the inner margins form a cutting edge; spiracles well developed, near the eye; gill openings moderate, all in advance of pectorals; first dorsal larger than the second, far in front of the ventrals, which are behind the middle of the body; second dorsal behind ventrals; dorsal spines strong, not grooved; caudal fin with unequal lobes, the upper elongate, broad, subtruncate at the end, the lower short and rounded; pectorals large and long, placed low down; ventrals midway between end of first and beginning of second dorsal. No anal fin.

21 Squalus acanthias Linnaeus

Spined Dogfish

Squalus acanthias LINNAEUS, Syst. Nat. ed. X, I, 233, 1758; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 16, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 54, 1896.

Spinax acanthias DE KAY, N. Y. Fauna, Fishes, 359, pl. 64, fig. 210, 1842.

Acanthias americanus STORER, Hist. Fish. Mass. 256, pl. XXXVIII, fig. 1, 1a, 1867.

Acanthias vulgaris GÜNTHER, Cat. Fish. Brit. Mus. VIII, 418, 1870.

Body slender, moderately long, its greatest depth about one eighth of the total length, and about three fourths of the length of the head; caudal fin scarcely bent upward, its length nearly one fifth of the total length; snout pointed, its length equaling about one fourth of the length of the head; mouth slightly arched, with a long, straight, deep, oblique groove on each side, without labial folds. Teeth small, equal in both jaws, their points turned aside so that the inner margins form a cutting edge; spiracles well developed, just behind the eye; eye large, oblong, its diameter two thirds of the length of the snout; no nictitating membrane; gill openings narrow slits, in front of the pectorals; first dorsal moderate, larger than the second, far in advance of the postmedian ventrals, which are in front of the small second dorsal; pectoral when extended reaches to below the first dorsal spine, its length contained about seven times in the total, including caudal fin; ventral one fourth as long as the head.

Color dark slate or gray on upper parts, whitish below, numerous white spots on the back, becoming faint or obsolete with age. The spined dogfish reaches a length of 3½ feet and the weight of 20 pounds. It inhabits both coasts of the Atlantic and is recorded also from Cuba. It is found in Gravesend bay, Long Island, only in October, and young examples have been taken at Southampton in the same month. The species is common in summer and fall on the fishing banks off the New Jersey coast. It is not hardy in captivity.

At Woods Hole Mass., according to Dr Smith, it is less abundant than formerly, and was comparatively scarce in 1897. When the fish fertilizer factory was established at Woods Hole, this was the principal fish utilized in the manufacture of oil and guano; later, the scarcity or irregularity of the supply necessitated the use of menhaden.

When the horned dogfish first comes, in May, it feeds largely on ctenophores.

In Massachusetts bay the species arrives in June and remains only a few days, but returns again in September and stays till

the middle of November. These fish are usually caught with the hook and often entangle themselves in nets, to which they do great damage. They feed on mackerel, whiting and other fishes.

The oil of the liver is an article of commerce, the flesh is useful for fertilizers, and the skin has been used for polishing; on some parts of Cape Cod the fish has been dried for fuel.

Mitchill mentions the spined dogfish only in one of his minor papers. De Kay recorded it as common on the New York coast. He found remains of the soft clam and scales of fishes in its stomach.

Suborder TECTOSPONDYLI

Family SQUATINIDAE

Angel Sharks

Genus SQUATINA Duméril

Body flat, depressed as in the rays, the snout obtuse or slightly concave in front; nostrils on the front margin of the snout with skinny flaps; mouth anterior; teeth in many series, conical, pointed, distant; spiracles wide, transverse, behind the eyes; gill openings wide, very near each other, partly inferior and partly hidden by the pectoral fins; two small, subequal dorsal fins on the tail behind the ventrals; no anal fin; caudal small, the lower lobe longer than the upper; males with small prehensile organs; vertebrae tectospondylous.

22 Squatina squatina (Linnaeus)

Angel fish; Monkfish

Squalus squatina Linnaeus, Syst. Nat. ed. X, 233, 1758.
Squatina dumerili De Kay, N. Y. Fauna, Fishes, 363, pl. 62, fig. 203, 1842.
Rhina squatina Günther, Cat. Fish. Brit. Mus. VIII, 430, 1870.
Squatina angelus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 35, 1883.
Squatina squatina Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 58; Smith, Bull. U. S. F. C. XVII, 89, 1898.

Body raylike in shape, flat, depressed, its greatest depth less than one fourteenth of the total length and about one third of the length of the head; caudal peduncle stout; caudal fin small, its lower lobe the longer; snout short, rounded; nostrils on its front margin, with skinny flaps. Mouth anterior, its width

about equal to the interorbital width; teeth acute, small, conical, distant; spiracles large, crescentic, behind the eyes; eye small, its diameter one fourth of the distance between the eyes; gill openings wide, subinferior, partly covered by the pectoral fin; two small dorsal fins, close together, behind the ventrals; anal fin wanting; pectoral fins very large, widely expanded, deeply notched at the base; ventrals very large, their length greater than that of the head; skin covered with stiff prickles, largest on the median line of the back.

Color bluish ashy gray or brown above, sometimes blotched and speckled, pale below. The monkfish reaches a length of 4 feet. It is easily recognized by its peculiar shape. It inhabits the Mediterranean and the Atlantic and Pacific coasts of the United States from Cape Cod and San Francisco southward. It is not common in New York waters, but it appears occasionally in Gravesend bay in summer and is believed to occur in this state only in bays adjacent to the Atlantic.

Mitchill, apparently, was not familiar with the species. De Kay knew the fish only from Le Sueur's descriptions and the writings of other ichthyologists. He gives the common names employed in Europe; monk, monkeyfish, kingston, shark ray, and fiddlefish. A New York fisherman informed De Kay that it was known to him as the little bullhead shark.

A specimen weighing 35 or 40 pounds and measuring about 4 feet was taken in a trap at Menemsha bight, Marthas Vineyard, Sep. 1, 1873. The writer saw one taken at the same place a few years later.

Order BATOIDEI

Rays

Suborder SARCURA

Family RAJIDAE

Skates

Genus RAJA (Artedi) Linnaeus

In the rays the disk is broad, rhombic; the pectorals extend to, but not around the snout; the ventrals are large and deeply notched; the tail is usually long, without serrated spine, slender,

rounded, or depressed, with caudal fin small or absent, with two small dorsal fins, close together, near its tip, and with a dermal fold on each side. The skin is more or less covered with prickles and spines, males having rows of erectile hooks near the outer angles of the pectorals. No electric organs. Eggs laid in leathery, four-angled cases, having two long tubular tendrils at each end. Teeth in the middle of the jaws, sharp in males, blunt in females.

23 **Raja erinacea** Mitchill

Common Skate; Prickly Skate; Hedgehog Ray

Raja erinaceus Mitchill, Am. Jour. Sci. Arts, IX, 290, pl. 6 (male), 1825; De Kay, N. Y. Fauna, Fishes, 372, pl. 78, fig. 246, 1842.
Raja eglanteria Gunther, Cat. Fish. Brit. Mus. VIII, 462, 1870.
Raia erinacea Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 40, 1883.
Raja erinacea Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 68, pl. IX, fig. 29, 1896; Smith, Bull. U. S. F. C. XVII, 89, 1898.

Disk rhomboid, with the angles rounded; its length nearly equal to its width; spines largest on the anterior extensions of the pectorals, where they are close set, strong, laterally compressed and hooked backward; smaller spines scattered over the head, above the spiracles, above and in front of the eyes, on the back, the median line of which is comparatively smooth, without enlarged spines except in the young; a triangular patch of spines on the shoulder girdle; inner posterior angles of the pectorals nearly smooth. Males have two rows of large, erectile hooks, pointing backward, near the outer angles of the pectorals. Females have groups of small scales on each side of the vent. Tail about as long as the disk; a dermal fold on each side; dorsal fins rough, connected at the base; mouth small; jaws curved, with small teeth in about 50 rows above and 48 below, the middle ones sharp in males, all blunt in females. Color light brown, with small round spots of dark brown. Length 1 to 2 feet. (After Garman)

A very common species on our coast, from Maine to Virginia. It is one of the small rays and is not much valued for food. Eggs of this skate have been obtained in Gravesend bay in March. In captivity eggs have been deposited in winter. The

species will endure captivity during the spring, fall, and part of the winter, but not at all in summer.

Mitchill had the ray from Barnegat and from off Sandy Hook. De Kay did not see the fish, but copied the description and figure of Mitchill. Smith refers to it as the "summer skate" or "bonnet skate." It is found at Woods Hole from June to October. The names "hedgehog ray" and "bonnet skate" are given in allusion to its habit of rolling itself up when caught. At Southampton L. I. this species was taken in small numbers Aug. 3, 1898.

24 Raja ocellata Mitchill

Spotted Skate; Big Skate

Raja ocellata Mitchill, Trans. Lit. & Phil. Soc. N. Y. 1, 477, 1815; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 68, pl. X, fig. 30, 1896; Smith, Bull. U. S. F. C. XVII, 89, 1898.

Raja ocellata De Kay, N. Y. Fauna, Fishes, 369, not pl. 65, fig. 212, 1842; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 40, 1883.

Similar in shape to R. erinacea, but larger, with a wider mouth and with many more rows of teeth. The length of the disk slightly exceeds its width. The spines are arranged as in R. erinacea, but additional rows are present down the back and on the sides of the tail. Tail nearly as long as the disk; caudal fin not separate, with small spines; mouth large; jaws curved; teeth in about 90 rows above and 88 below. Color light brown, with rounded dark spots; a translucent space on each side of the snout; near the posterior angle of the pectoral there is usually (but not always) a large white ocellus, with a dark spot in the center and a darker border; two smaller similar spots often present. (After Garman)

The spotted skate reaches a length of nearly 3 feet; its egg cases are more than twice as large as those of R. erinacea. The species is found from New York to Massachusetts and northward.

Dr Mitchill described a specimen which was 30 inches long and 19 inches wide. Dr De Kay calls this species the spotted ray. He found the stomach of one filled with rock crabs, Cancer irroratus. To the fishermen this and allied spe-

cies are known as skate. It has no commercial value in Great South bay. In the traps at Islip skates reappear on October first on their fall migration. A female was caught near the inlet at Fire Island, Sep. 29, 1898. The species was more abundant later in the fall.

At Woods Hole, according to Dr Smith, this is the big skate or winter skate. It is common from February to June and from October 15 to the end of the trap fishing; it is absent or very rare in summer.

25 Raja eglanteria Bosc

Clear-nosed Skate; Brier Ray

Raja eglanteria Bosc in Lacépède, Hist. Nat. Poiss. II, 164, 169, 1800; Günther, Cat. Fish. Brit. Mus. VIII, 462, 1870; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 71, 1896; Smith, Bull. U. S. F. C. XVII, 89, 1898.
Raia eglanteria Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 41, 1883.
Raja diaphanes Mitchill, Trans. Lit. & Phil. Soc. N. Y. 478, 1815.

Differs from R. erinacea and R. ocellata in its acutely produced snout, smaller spines and translucent space on each side of the rostrum. The length of the disk (12 inches) equals four fifths of its width (15 inches). Spines small and very sharp, most numerous on the front part of the pectoral, the head, the snout, the middle of the back, and the tail between the rows of enlarged spines; enlarged spines around the eyes and spiracles, on the middle of the snout, in a median row along the back, and in two rows along each side of the tail. The spines on the tail are very sharp, large and small ones alternating in the rows; a large spine in the middle of each shoulder; a spine between the dorsal fins; tail as long as the disk, and with a median and two lateral rows of moderately large spines and one or more intermediate rows of much smaller ones; caudal fin absent or very small; dorsals small, the anterior larger, one ninth the length of tail in hight; mouth moderate; teeth in about 50 rows in upper jaw and 48 in the lower.

Color pale brown, with numerous bands, bars, lines and blotches of darker; darker spots in the middle of the pectoral; each side of the snout with a pale, translucent area.

The clear nosed skate, sometimes called brier ray, reaches a length of 2 feet or more. It inhabits the eastern coast of the United States from Cape Cod to Florida; it has been found moderately common in Great South bay in and near Fire Island inlet. Early in September both males and females were caught at Fire Island inlet and Wigo inlet, but in October the species appeared to be scarce. It has no commercial value in the bay and is usually thrown away.

At Woods Hole Mass. it is not common. A few are taken every year in traps at Menemsha, Marthas Vineyard.

26 Raja laevis (Mitchill)

Barn-door Skate

Raja laevis Mitchill, Am. Month. Mag. II, 327, 1818; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 71, 1896; Smith, Bull. U. S. F. C. XVII, 89, 1898.

Raja laevis De Kay, N. Y. Fauna, Fishes, 370, 1842; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 42, 1883; Storer, Hist. Fish. Mass. 266, pl. XXXIX, fig. 2, 1867.

Similar in shape to R. eglanteria, but larger and with fewer rows of teeth. The length of the disk equals three fourths of its width. The spines of the body are few and small; small patches of slightly enlarged spines on the anterior extension of the pectorals opposite the eyes and spiracles; slightly enlarged, hooked spines in several narrow rows on the angles of the disk in males; a median row, more or less incomplete, of distant spines on the tail and usually a lateral row on each side, many of these lateral spines sometimes obsolete; small spines on the snout, along the anterior edges of the disk, and on the top of the head. Tail nearly as long as the disk; two subequal dorsal fins, scarcely half as long as the snout, separated by a narrow interspace and extending to near the end of the tail; no caudal fin; eye one fifth as long as the snout; mouth large, jaws curved, teeth in about 30 rows in each jaw; length of claspers of the male equals one third of the width of the disk. Color usually brownish with paler spots, these sometimes surrounded by dark rings.

The barn-door skate reaches a length exceeding 4 feet; it is used to some extent for food. The species has been taken in Gravesend bay in October. It suffers in captivity for the want of sand and mud and because of the lack of suitable food, its average duration of life is 3 or 4 months.

Mitchill described an individual measuring 49 inches which was caught at a wharf in the East river Nov. 5, 1815. At Woods Hole Mass. it is common in spring and fall, rare in summer.

Family NARCOBATIDAE

Electric Rays

Genus TETRONARCE Gill

Rays with a large electric organ composed of many hexagonal tubes between the pectoral fins and the head; disk very broad, abruptly contracted at the tail; two dorsal fins, the first much the larger, its origin not far in advance of the end of the ventrals; caudal fin well developed; ventral fins large, separate; spiracles large, oblong, well behind the eyes, with entire edges; mouth small; teeth sharp; skin smooth. Seas of Europe and America.

27 Tetronarce occidentalis (Storer)

Torpedo; Cramp Fish; Numb Fish

Torpedo occidentalis STORER, Am. Jour. Sci. Arts, 165, pl. 3, 1843; Hist. Fish. Mass. 271, pl. XXXIX, fig. 5, 1867; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 39, 1883.

Raja torpedo MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 476, 1815.

Tetronarce occidentalis JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 77, pl. XI, fig. 33, 1896; SMITH, Bull. U. S. F. C. XVII, 89, 1898.

Length of disk equals six sevenths of its width and more than one half the total length; length of base of ventrals equals one fourth the width of disk; eyes small, placed three times their diameter from tip of snout, and about the same distance from each other; length of first dorsal base nearly equals distance between the spiracles; hight of first dorsal fin exceeds length of snout; base of second dorsal scarcely more than one half the length of first, the hight of the fin hardly two thirds of that of

first; caudal slightly emarginate, its width and length nearly equal, about two sevenths of width of disk. The upper surface is dark purplish brown with a few darker spots distributed over it; beneath white.

The torpedo is found on the Atlantic coast of the United States from Cape Cod to Florida; it occurs also in the West Indies. The fish is usually uncommon except in Buzzards bay and Vineyard sound. It reaches the length of 5 feet and the weight of 100 pounds.

Mitchill placed a torpedo among the fishes of New York on the authority of fishermen and others who had seen the species and knew of its peculiar electric properties. De Kay did not see the fish and merely refers to the probability of its occurrence and its relation to the genus Torpedo.

The existence of a torpedo on the coast of Massachusetts was made known by Storer in 1843, when he described a specimen caught at Wellfleet, in November 1842. Capt. Atwood, a well known former resident of Provincetown Mass. informed Dr Storer that he had received a great many powerful shocks from the fish which threw him to the ground; these were produced by touching the animal. He also received shocks by taking hold of a harpoon which was struck into the fish. Storer relates an anecdote illustrating the effect produced on a dog.

Mr Newcomb sr, the oldest fisherman in Boston market, stated to me that his father, who resided at Wellfleet, had a dog which frequently waded into the shallow waters of the coves and brought out flounders which he had seized with his mouth. In one of his fishing excursions he attacked a torpedo, which perfectly convulsed him. He dropped the fish and ran away howling most piteously, and could never be persuaded to resume his fishing.

At Woods Hole Mass. the torpedo is most abundant in October and November. At times as many as six are taken at one lift of a trap at Menemsha. The smallest weigh 4 or 5 pounds, the largest 75 pounds.

Suborder MASTICURA

Whip-tailed Rays

Family DASYATIDAE

Sting Rays

Genus DASYATIS Rafinesque

Disk usually broader than long; pectoral fins united in front to form the tip of the snout; tail very slender and elongate, finless, but often with one or two membranous folds, and with a strong serrated spine near its base; skin rarely smooth, usually more or less spinous or prickly, tail with numerous small spines in some species; mouth small; teeth small, paved, usually more or less pointed or tubercular; a few papillae, usually in the mouth behind the lower jaw; nostrils close together; nasal valves forming a rectangular flap, which is joined to the upper jaw by a narrow frenum; spiracles large, placed close behind the eyes. Ovoviviparous.

28 Dasyatis centrura (Mitchill)

Common Sting Ray

Raja centrura MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I. 479, 1815.
Pastinaca hastata STORER, Hist. Fish. Mass. 268, pl. XXXIX, fig. 3, 1867.
Dasibatis centrura JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 67, 1883.
(From Garman)
Trygon hastata GUNTHER, Cat. Fish. Brit. Mus. VIII, 476, 1870.
Dasyatis centrura JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 83, 1896; SMITH, Bull. U. S. F. C. XVII, 90, 1898.

Disk quadrangular, about one fourth wider than long; anterior margins sinuous, concave opposite the eyes, convex toward the slightly protuberant snout and rounded over angles; posterior straighter, very little convex; hinder angles blunt; ventrals truncate, with rounded angles; tail more than twice as long as the body, much compressed, rounded above, with keel or cutaneous expansion below, with one or more strong serrated spines at the termination of the anterior fifth of its length, rough on all sides with spines or tubercles. Till half grown the young are naked; as they approach maturity broad stellate based, conical pointed, irregularly placed bucklers appear on the middle of the hinder part of the back and on the top and sides

of the tail. Very large examples have the central part of the back closely mailed with small flattened tubercles. The buckiers bear more resemblance to those of the Rajae, radiata and clavata, than to the tubercles of pastinaca, hastata, or tuberculata. Mouth arched forward, with five papillae; teeth in quincunx, blunt, smooth. Color of back and tail olive brown; light to white below. From pastinaca, which this species resembles in shape, it is distinguished by the tubercles, by the length and compression of the tail, and absence of all trace of keel or expansion on its upper side. A young specimen measures from snout to tail 13.8, in length of tail 30.5, and width of pectorals 17.5 inches. The largest specimen in the collection has a total length of 10 feet 3 inches (Coll. Mus. Comp. Zool. Cambridge Mass.). Common south of Cape Cod. Occasionally found northward. (After Garman)

Formerly hundreds of individuals were caught annually in Gravesend bay, but now it is seldom seen there. The species will live in captivity several months in the spring and summer. Mitchill records it as occurring on the coast of Long Island. The tail, he states, is 5 feet or more in length. Storer described a specimen 9 feet long. He was informed by Dr Yale that the fish was abundant on the flats in the harbor of Holmes's Hole, Marthas Vineyard, in July and August. Near Woods Hole Mass. it is common during summer, appearing early in July.

The sting ray is much dreaded by fishermen, who say that wounds made by its spines are exceedingly painful and dangerous, the slime secreted by the fish acting as a poison.

Subgenus DASYATIS

29 Dasyatis hastata (De Kay)

Kit

Pastinaca hastata De Kay, N. Y. Fauna, Fishes, 373, pl. 65, fig. 214, 1842.
Trygon hastata Storer, Syn. Fish. N. A. 261, 1846.
Dasibatis hastata Garman, Bull. 16, U. S. Nat. Mus. 70, 1883.
Dasyatis hastata Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 83, 1896.

The sting rays of the subgenus Dasyatis differ from the type centrura in having a narrow keel or expansion on the tail both above and below.

Disk with the shape and proportions of D. centrura; anterior margins nearly straight, meeting in a blunt angle on the end of the snout, curved near the outer angle to meet the slightly convex posterior margins; inner borders convex; outer and hinder angles rounded; ventrals almost entirely covered by the pectorals, their hinder margins convex; tail more than one and one half times as long as the disk, with a low keel on the upper side, a long, broad, membranous expansion below, roughened with small asperities, and with one or more serrated spines beginning in the first fourth of its length; body smooth in young, with scattered small asperities in the old; a row of narrow, compressed tubercles on the middle of the back and base of tail, their points depressed and directed backward. On each shoulder, parallel with the median row, there is a shorter row varying in length according to age. Mouth with three papillae; jaws more curved than in centrura and less than in sabina. Color bluish or uniform olive brown above, white beneath. West Indies to Brazil, north to Rhode Island.

De Kay's description of his whip sting ray is based on a female captured in September off the coast of Rhode Island by Carson Brevoort of New York. The length of the fish was 8 feet 6 inches and its weight 110 pounds. Mr Brevoort stated that the whip rays appeared to associate together, as he noticed many of similar size and appearance swimming about at the same time. They moved slowly together through the water, along the edges of the rocks, about 3 feet below the surface. When captured, the individual described by Dr De Kay whipped its tail about with great activity in all directions. From this circumstance it derives the name of whip ray.

30 Dasyatis say (Le Sueur)

Southern Sting Ray

Raja say Le Sueur, Jour. Ac. Nat. Sci. Phila. I, 42, 1817.
Myliobatis? say De Kay, N. Y. Fauna, Fishes, 376, 1842.
Trygon sayi Müller & Henle, Plagiostomen, 166, 1841; Duméril, Elasmobranches, 603, 1870.
Dasybatis sayi Garman, Bull. 16, U. S. Nat. Mus. 69, 1883.
Dasyatis say Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 86, 1896.

Disk quadrangular, about one sixth wider than long, anterior margins nearly straight, posterior and inner borders convex, outer and posterior angles rounded; snout not protruding beyond the lines of the margins, ventrals rounded; tail strong, rather more than one and one half times the length of disk, with a strong serrated spine, bearing a short, low cutaneous expansion behind the spine on the upper side, and a longer, little wider one below, ending nearly opposite; upper jaw undulated, lower prominent in the middle; teeth small, smooth in young and females, sharp in adult males; three papillae at the bottom of the mouth, and one at each side; body and tail naked. Color olive brown in adult, reddish or yellowish in young; lower surface whitish. New York to Florida and Brazil. (After Garman)

According to Garman, a young female measured from snout to tail 7.1, length of tail was 11, and width of pectorals 8.2 inches.

Le Sueur's type was from the New Jersey coast. Müller and Henle mention six specimens in the Museum of Natural History at Paris, which were sent from New York by Milbert. The species has not been reported recently in New York waters.

Genus PTEROPLATEA Müller & Henle

Disk much broader than long, its anterior margins meeting in a very obtuse angle, its outer angles more or less acute, the form, therefore, transversely rhombic; tail very short and slender, shorter than the disk, without fin, armed with a very small serrated spine or without spine; skin smooth or very nearly so. Size large.

31 Pteroplatea maclura (Le Sueur)

Butterfly Ray

Raia maclura LE SUEUR, Jour. Ac. Nat. Sci. Phila. I, 41, 1817.
Pastinaca maclura DE KAY, N. Y. Fauna, Fishes, 375, pl. 65, fig. 213, 1842.
Pteroplatea maclura MÜLLER & HENLE, Plagiostomen, 169, 1841; GÜNTHER, Cat. Fish. Brit. Mus. VIII, 487, 1870; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 46, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 86, 1896; SMITH, Bull. U. S. F. C. XVII, 90, 1898.

Disk almost twice as broad as long, covered with smooth skin (or with minute granulations according to Le Sueur), the snout

very little projecting, so that the anterior margin of each pectoral is slightly concave; tail two fifths to one third the length of disk, with a slight dermal fold above and below, and with one or two spines very near its base or sometimes without spines; eyes small and near the snout; spiracles large, near the eyes; nostrils small, near the mouth, not extending to the upper lip; teeth numerous, triangular, acute, each emarginate at the base behind; ventrals short, broad and rounded, their length less than one fifth of that of disk. Color brownish olive, sometimes bluish, finely marbled with grayish, and finely speckled; anterior edge of disk with blotches of paler; tail with four dark blotches above, forming half rings. Cape Cod to Brazil, common southward.

The species is now rarely seen in Gravesend bay. It does not endure captivity.

Le Sueur's description was based on a specimen 6 feet 7 inches wide, taken at Newport R. I. He was informed by fishermen that it reaches the width of 15 feet. De Kay copied Le Sueur's description and figure.

Dr Smith says it is rare at Woods Hole, and appears in August and September when present. It has the local name of Angel fish at Woods Hole.

Family MYLIOBATIDE

Eagle Rays

Genus MYLIOBATIS Duméril

Disk broad; pectoral fins ending laterally in an acute angle, not continued forward around the snout, but ceasing on the sides of the head and reappearing in front of the snout as a fleshy protuberance (cephalic fin); tail very long and slender, whiplike, with a small dorsal fin near its root, and one or more serrated spines; teeth hexangular, large, flat, tessellated, the middle ones much broader than long in the adult; several series of narrower teeth on each side of the median series; teeth changing considerably with age; jaws about equal; free edge of the nasal valve not deeply emarginate; skin smooth.

32 Myliobatis freminvillei (Le Sueur)

Eagle Ray

Myliobatis fréminvillei Le Sueur, Jour. Ac. Nat. Sci. Phila. IV, 111, 1824; De Kay, N. Y. Fauna, Fishes, 376, 1842.

Myliobatis acuta Storer, Hist. Fish. Mass. 269, pl. XXXIX, fig. 4, 1867.

Myliobatis freminvillei Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 51, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 89, 1896; Smith, Bull. U. S. F. C. XVII, 90, 1898.

Disk broader than long, width to length bearing the ratio of 5 to 3; width of disk equal to length of tail. Diameter of eye equals about one fourth of the interorbital distance; spiracles behind the eyes and one and one half times as long. Width of mouth one half its distance from tip of snout. Free edge of the nasal valve not deeply notched. Reaches a length of 4 feet. Body and head above, reddish brown; tail lighter at the base, but nearly black toward the tip; lower parts whitish.

The species is not uncommon, from Cape Cod to Brazil. It probably feeds on mollusks.

It was reported to me by men of the menhaden steamer *Annie Morris* that about Aug. 20, 1887, off Hereford inlet, they saw schools of sting rays at the surface "flopping along like geese." The schools were large enough to have filled a menhaden seine. The rays were said to have two spines on the tail.

Le Sueur's description was based on a Rhode Island specimen. De Kay copied briefly from Le Sueur, and placed the fish among the extra-limital species. William O. Ayres found an individual at Brook Haven L. I., which he described in the Boston *Journal of Natural History*, 4:290, pl. 13. Dr Storer received portions of a specimen from Holmes' Hole Mass. Dr Smith records it as not very common at Woods Hole Mass., but taken in small numbers every year in traps.

Genus RHINOPTERA Kuhl

Disk broader than long, its anterior angles more or less acute; snout more or less emarginate on the median line; cephalic fin emarginate and placed on a plane below the level of the pectorals, the snout thus appearing four-lobed; free border of the nasal valve not emarginate; teeth in 5 to 20 rows, the median

teeth sometimes much enlarged, sometimes not much larger than the outer teeth; tail long, whiplike, with a small dorsal spine behind the dorsal fin which is at the base of the tail; ventral fins oblong, truncated behind.

33 Rhinoptera bonasus (Mitchill)

Cow-nosed Ray

Raja bonasus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 479, 1815.
Rhinoptera quadriloba DE KAY, N. Y. Fauna, Fishes, 375, pl. 66, fig. 217, 1842; GUNTHER, Cat. Fish. Brit. Mus. VIII, 494, 1870; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 51, 1883.
Rhinoptera bonasus JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 90, 1896; SMITH, Bull. U. S. F. C. XVII, 90, 1898.

The length of disk equals two thirds of its width; its anterior borders almost straight, posterior undulated; pectorals acutely produced; muzzle deeply emarginate; mouth wide; nostrils midway between mouth and tip of snout; spiracles large, longer than eye; teeth in seven rows in each jaw, the median teeth more than four times as broad as long, the others gradually diminishing in size outward; tail very slender, as long as the body; a small dorsal fin at base of tail and a slender, serrate spine behind it; skin smooth except a few protuberances on the top of the head. Color olive brown above; beneath white. Cape Cod to Forida; not rare.

This species is now rarely seen in Gravesend bay, where it was at one time very common in the autumn. When Mitchill wrote of the fishes of New York (1815) he stated that the cownosed ray visits the coast, usually about September, in numerous shoals, entering the bay and ranging very extensively over the flats where the soft clam lives.

These shellfish he is supposed to devour; for a shoal of cownoses roots up the salt water flats as completely as a drove of hogs would do. I have seen the water in violent agitation when these fishes were at work in the bottom. They render it so muddy that they are concealed from sight. Frequently, however, they rise to the top and may be distinctly observed. I have seen them swim near the surface in clear water. They then support and propel themselves in their element by their large flaps as a crow or other bird, with slowly moving wings, passes through the air. They may be said to fly rather than to swim. A full grown individual weighs about 100 pounds.

Mitchill also states that the fishermen usually allow these rays to decay on the shores, but sometimes take out their livers for conversion into oil.

According to Dr Smith, the cow-nosed ray is common at Woods Hole Mass.

Subclass TELEOSTOMI

True Fishes

Series GANOIDEI

Ganoid Fishes

Order SELACHOSTOMI

Paddlefishes

Family POLYODONTIDAE

Paddlefishes

Genus POLYODON Lacépède

Body fusiform, elongate, somewhat compressed; skin smooth or with minute ossifications; snout produced into a very long spatulate process, the inner part composed of the produced nasal bones, the sides flexible and supported by a bony network; mouth wide, terminal, but overhung by the snout, without maxillaries, but with toothed premaxillaries; numerous fine, deciduous teeth in the jaws and on palatines; no tongue; nostrils double, immediately in front of the eye; spiracles present; operculum rudimentary, its skin produced behind into a long acute flap; no pseudobranchiae; no barbels; no opercular gill; gills four and one half; gill rakers numerous, very long and slender, in a double series on each arch, the two series divided by a broad membrane; gill membranes connected but free from isthmus; one broad branchiostegal; lateral line continuous, its lower margin with short branches; air bladder cellular, entire, communicating with the dorsal wall of the esophagus; pyloric caeca in the form of a short, broad, leaflike organ, with four or five larger divisions, each being subdivided; rectum with a fully developed spiral valve; dorsal fin posterior, without spines; anal similar, and more posterior; tail heterocercal, with well devel-

oped lower caudal lobe so that the fin is nearly equally forked; sides of the bent portion of the tail armed with small rhombic plates; upper caudal fulcrums narrow, numerous; pectorals moderate, placed low; ventrals abdominal, many-rayed.

Rivers of the middle United States.

34 **Polyodon spathula** (Walbaum)

Paddlefish; Spoonbill Cat

Squalus spathula Walbaum, Artedi, Gen. Pisc. 522, 1792.

Polyodon feuille Lacépède, Hist. Nat. Poiss. I, 403, 1800.

Polyodon folium Bloch & Schneider, Syst. Ichth. 157, 1801 (after Lacépède); Mitchill, Am. Jour. Sci. Arts, XII, 201, 1827; Kirtland, Bost. Jour. Nat. Hist. IV, 21, pl. 2, fig. 1, 1844; Günther, Cat. Fish. Brit. Mus. VIII, 346, 1870.

Polyodon spathula Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 83, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 101, 1896.

The body of the paddlefish is fusiform with the snout much produced, spatulalike. Body scaleless, covered with smooth skin; mouth broad, terminal, somewhat resembling that of the shark; teeth in jaws very numerous and fine, deciduous; spiracles with a minute barbel. The operculum is rudimentary, its flap of skin long, reaching almost or quite to the ventral fins; pseudobranchiae absent; gill arches five, the last rudimentary; gill rakers long and in a double series on each arch; gill membranes connected, free from the isthmus; nostrils double, situated at base of blade; a continuous lateral line from upper part of head along dorsal outline to tail; eye small, directed downward and to the side; dorsal and anal fins far back, composed of soft rays, nearly opposite; tail heterocercal, well forked; sides of the bent portion of the tail armed with rhombic plates. The pectoral fins are of moderate size and placed low; ventrals many-rayed, abdominal. The distance from eye to end of snout is about one third of the total length, including caudal. The depth of the body is contained four and one half times in the distance from eye to base of caudal. The hight of the dorsal fin about equals the depth of the body.

This is known as the paddlefish, spoonbill or spoon-billed sturgeon, shovel fish, billfish, and duck-billed cat. Called "sal-

mon" in western hotels. The names are derived from the remarkable snout, which is produced into a long spatula-shaped process, covered above and below with an intricate network and with very thin flexible edges. The head and snout form nearly half of the entire length of the fish. The fish can not be confounded with anything else in the waters of the United States. There is in China a similar fish, which, however, belongs to a different genus.

Distribution. The single species of American paddlefish is confined to the Mississippi valley. It inhabits only the larger streams in Pennsylvania. It is common in the Allegheny and the Monongahela rivers.

Size. The paddlefish grows to a length of 6 feet, and a weight of 30 pounds or more.

Habits. The species frequents muddy bottoms, but does not feed on the mud and slime, as many persons have supposed. The long snout is useful in procuring its food, which consists chiefly of entomostracans, water worms, aquatic plants, leeches, beetles and insect larvae.

Prof. S. A. Forbes, director of the Illinois Laboratory of Natural History, has published the first and most satisfactory account of the feeding habits of this sharklike fish. He found very little mud mixed with the food. Prof. Forbes was informed by the fishermen that the paddlefish plows up the mud in feeding with its spatulalike snout and then swims slowly backward through the water.

"The remarkably developed gill rakers of this species are very numerous and fine, in a double row on each gill arch, and they are twice as long as the filaments of the gill. By their interlacing they form a strainer scarcely less effective than the fringes of the baleen plates of the whale, and probably allow the passage of the fine silt of the river bed when this is thrown into the water by the shovel of the fish but arrests everything as large as the cyclops. I have not found anything recorded as to the spawning habits of the paddlefish. The young have the jaws and palate filled with minute teeth, which disappear with age."

Mode of capture. The fish are generally caught by seining.

Edible qualities. The flesh of the paddlefish is frequently considered tough and sharklike, but individuals of 8 or 10 pounds are skinned, and sold in some of the western markets freely, and are thought by some persons to be fairly good for the table.

Order CHONDROSTEI

Sturgeons

Family ACIPENSERIDAE

Sturgeons

Genus ACIPENSER Linnaeus

Body elongate, subcylindric, armed with five rows of bony bucklers, each with a median keel terminating in a spine which becomes obsolete with age; a median dorsal series of bucklers, and a lateral and abdominal series on each side, the abdominal series sometimes deciduous; between these the skin is rough with small, irregular plates. Head covered with bony plates joined by sutures; snout produced, subconic; spiracles present; mouth small, inferior, protractile, with thickened lips; no teeth; gill rakers lanceolate; four barbels in a transverse series on the lower side of the snout in front of the mouth; eyes small; nostrils large, double, in front of eye; gills four; an accessory opercular gill; gill membranes united to isthmus; pseudobranchiae small or obsolete; no branchiostegals; maxillary distinct from the premaxillary; fin rays slender, all articulated; vertical fins with fulcrums; pectorals placed low; ventrals many-rayed, behind middle of body; dorsal placed posteriorly; anal somewhat behind dorsal, similar; tail heterocercal, the lower caudal lobe developed; the tail not depressed or mailed; air bladder large, simple, connected with the esophagus; stomach without blind sac; rectum with a spiral valve; pancreas divided into pyloric appendages. (After Jordan and Evermann)

35 Acipenser sturio Linnaeus

Common Sturgeon

Acipenser sturio LINNAEUS, Syst. Nat. ed. X, 237, 1758; GÜNTHER, Cat. Fish. Brit. Mus. VIII, 342, 1870; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 105, 1896; SMITH, Bull. U. S. F. C. XVI, 90, 1898.

Acipenser oxyrinchus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. 1, 462. 1815
Acipenser oxyrhinchus DE KAY, N. Y. Fauna, Fishes, 396, pl. 58, fig. 189 (young), 1842.
Acipenser sturio var. *oxyrhynchus* JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 86, 1883.

The common or sharp-nosed sturgeon has a stout, roundish and elongate body, its hight equaling one half the length of the head and one sixth of the total without the caudal. The least depth of the tail equals one third of the greatest body depth. The head is long, one third of total without the caudal, and the snout is as long as the rest of the head in the young. The eye is one sixth as long as the snout. Two pairs of short, slender barbels midway between the mouth and tip of snout. The front of the mouth is nearly under the posterior edge of the pupil. The nostrils are double, the posterior pair more than twice as large as the anterior. The dorsal and anal fins are placed far back and opposite to each other. The distance of the ventral origin from the end of the lower caudal lobe equals the length of the head. The upper caudal lobe is nearly twice as long as the lower. D. 38 to 40; A. 23 to 26; V. 24. Lateral plates 27 to 29; dorsal shields 10 to 14; ventral shields 11 or 12.

The color of the upper parts is dark olive gray, sometimes brownish; the lower parts are light gray or whitish. The pupils are black; the iris golden.

The range of the common sturgeon includes the Atlantic ocean southward to Africa and the West Indies. The northern limit on our east coast appears to be Cape Cod. In the Delaware river the fish has rarely ascended as far as Port Jervis.

Dr Mitchill was the first to call attention to the similarity between the American sharp-nosed sturgeon and the sturio of Europe. The fish attains a length of 12 feet in America, and it is stated that European examples measuring 18 feet have been taken.

The sturgeon ascends the large rivers from the sea in spring and early summer. It is very common in the lower part of the Delaware river, where it forms the object of an important fishery. This is the species concerning which so many stories have

been related as to leaping into boats and injuring the occupants.

The mouth of the sturgeon is furnished with a very protractile roundish tube having powerful muscles and intended for withdrawing from the mud the various small shellfish and crustaceans on which the animal subsists. The mouth is surrounded also with numerous tentacles, with tactile properties, which are utilized in procuring food.

The reproductive habits of the sturgeon and the embryology of the species have been made the subject of an exhaustive study by Prof. John A. Ryder, of the University of Pennsylvania, whose monograph forms a part of the Bulletin of the U. S. Fish Commission for 1888. The eggs have been fertilized and developed artificially by Seth Green and others many years ago, and in some parts of Europe the hatching of the species has been carried on successfully. The U. S. Fish Commission has also recently taken up the culture both of the marine and the lake sturgeon, and these valuable fish may soon be reared on an extensive scale.

The utilization of the flesh, the skin and air bladder and the eggs of the sturgeon is so well known as to require little more than passing mention in this place. The smoking of the flesh and the manufacture of caviar from the eggs are very important industries along our eastern coast.

The sturgeons are easily taken in gill nets and pounds, but the great strength of the fish frequently entails considerable loss of apparatus.

The common sturgeon appears every spring in Gravesend bay, and sometimes in the fall. It is hardy in captivity.

A female 8 feet long was brought from the mouth of the Delaware river May 20, 1897, to the New York aquarium. It seemed to take no food till December 1, when it began to feed freely on opened hard clams. Early in November 1898, the fish was still alive and healthy.

36 Acipenser rubicundus Le Sueur

Lake Sturgeon

Acipenser rubicundus Le Sueur, Trans. Am. Phil. Soc. I, 388, 1818; De Kay, N. Y. Fauna, Fishes, 344, pl. 58, fig. 191, 1842; Günther, Cat. Fish. Brit. Mus. VIII, 338, 1870; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 87, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 106, 1896.

Acipenser maculosus Gunther, Cat. Fish. Brit. Mus. VIII, 339, 1870.

The body of the lake sturgeon is rather more slender than that of the common sturgeon. The snout is rather blunt; in the young long and slender. The shields of the body are large, about 14 on the back, 30 or more on the side, and eight or nine along the abdomen, between pectoral and ventral fins. Each shield is surmounted by a strong hooked spine. The head is contained three and one third times in the length without tail. Barbels four, rather long; eye small; dorsal and anal fins small, placed far back as in the pike. D. 35; A. 26.

This is known as the lake sturgeon, Ohio river sturgeon, rock sturgeon, bony sturgeon, red sturgeon and ruddy sturgeon. It inhabits the Mississippi and Ohio rivers and the Great lakes, and is abundant in the Allegheny. From the lakes it ascends the streams in spring for the purpose of spawning. Dr Richardson states the northern limit of the sturgeon in North America to be about the 55th parallel of latitude.

Size. The lake sturgeon is smaller than the common marine sturgeon, the average adult being less than 5 feet in length. The average weight of 14,000 mature sturgeon taken at Sandusky O. was about 50 pounds. It frequently reaches a length of 6 feet.

Habits. In the lakes the species, according to observations of James W. Milner, inhabits comparatively shoal waters.

The food of this sturgeon is made up chiefly of shellfish, including the genera Limnaea, Melantho, Physa, Planorbis, and Valvata. Eggs of fishes are also to be found in its stomach.

In Lake Erie the species spawns in June, for which purpose it ascends the rivers in large schools till stopped by obstructions

or insufficient depth of water. The breaching of the sturgeon is a well known habit. Instances are recorded of serious injury to persons by sturgeons throwing themselves into boats. The sturgeon will occasionally take a baited hook, but its great strength and unwieldiness make it an undesirable fish for the angler.

Large numbers of sturgeon have been destroyed by fishermen during the whitefish season simply on account of the annoyance caused by their presence in the nets. Now that the flesh is coming to be esteemed for smoking, and the demand for caviar made from their eggs has largely increased, the wanton waste of this fish has been checked. A troublesome parasite of the sturgeon is the lamprey eel (Petromyzon concolor Kirt.) which attaches itself to the skin presumably for the purpose of feeding on the mucus, which is exuded from the pores in great abundance, and remains fixed in one position so long as to penetrate to the flesh and produce a deep ulcerous sore.

The lake sturgeon was formerly not very much prized, but is rapidly growing in favor. The flesh is eaten in the fresh condition or after boiling in vinegar or curing by smoking. Smoked sturgeon is now considered almost if not quite equal to smoked halibut, and the demand for it is increasing. From the eggs of the sturgeon a good grade of caviar is produced. "The caviar is made by pressing the ova through seives, leaving the membranes of the ovaries remaining in the sieve, and the eggs fall through into a tub. This is continued until the eggs are entirely free from particles of membrane, when they are put into salt pickle and allowed to remain for some time."

A large specimen now in the museum of Cornell University is reported as being from Cayuga lake. Seth Green informed Dr Meek that sturgeons had occasionally been taken in that lake; but, so far as he knew, they had never been found in any other of the small lakes of central New York.

H. V. Kipp of Montezuma N. Y. wrote Dr Meek as follows:

There have not been any sturgeons taken from Cayuga lake since 1880, but quite a number before that date, and the largest known weighed 35 pounds.

37 Acipenser brevirostrum LeSueur

Short-nosed Sturgeon

Acipenser brevirostrum LE SUEUR, Trans. Am. Phil. Soc. I, 390, 1818; RYDER, Bull. U. S. F. C. VIII, 237, 1890; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 106, 1896.

Acipenser brevirostris GÜNTHER, Cat. Fish. Brit. Mus. VIII, 341, 1870; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 87, 1883; SMITH, Bull. U. S. F. C. XVII, 90, 1898.

In the short-nosed sturgeon the snout is very blunt and only about one fourth to one third as long as the head. The four short barbels are a little nearer to the end of the snout than to the mouth, and do not reach to the mouth. The head is one fifth to two ninths as long as the total to the fork of the tail; the distance between the eyes slightly greater than length of snout and somewhat more than one third of length of head. The average number of bucklers in the dorsal series is 10 to 11; in the lateral series, 25; in the ventral row, seven to eight. No preanal scutes. The unarmored part of the skin, according to recent observations of Prof. John A. Ryder, is almost free from prickles and ossifications. D. 33; A. 19 to 22; V. 17 to 21; P. 30 to 31; C. 60, its lower lobe two fifths as long as the upper, measuring from the fork. The color of the skin of the upper parts is reddish brown; lower parts nearly white; peritoneum dark brown; viscera almost black.

This little-known sturgeon has not been generally recognized anywhere except in the Delaware and in Gravesend bay; only a few specimens have been obtained in the river, and it is rare in Gravesend bay. Prof. Ryder collected five examples at Delaware City in the spring of 1888 and has published a description of the species in the Bulletin of the U. S. Fish Commission for that year.

Size. The largest specimen known was 33 inches long; individuals 20 inches long are capable of reproducing the species.

Uses. At the present time the short-nosed sturgeon probably never comes into the markets, on account of its small size, which prevents its capture in the nets used for taking the common sturgeon. About 1817, however, it was brought in the shad season to Philadelphia and sold for 25c to 75c each.

Reproduction. Spawning takes place in the Delaware during May. The eggs are deposited in depths of 1 to 5 fathoms on hard bottom in brackish or nearly fresh water. Prof. Ryder states that the eggs are extruded by rubbing the belly either against hard places on the river bed or against the rough bodies of the males, two or more of which accompany each female. The gravid roe fish are larger than the males. Prof. Ryder found the ova more or less adhesive immediately after their removal from the abdomen, but the sticky mucous covering is soluble in water. The period of hatching varies from four to six days.

Food. Up to the third month of its life the young sturgeon has minute conical teeth in its jaws, and at this age it is believed to subsist on "rhizopods, unicellular algae, infusoria, minute larvae of insects and worms, crustaceans, etc." Still following the observations of Prof. Ryder, we learn that the sturgeon, when it has reached a length of 1 inch to 1½ inches, has minute teeth on the floor of the pharynx and feeds on small water fleas, and probably algae, worms, embryo fishes, insects and fresh-water copepods. Later in life the fish seeks larger crustaceans, and the adults occasionally contain fragments of mussel shells. The young fish have been caught under the ice in midwinter and are known to pass most of the year in fresh water.

A single small example of this sturgeon was brought to the New York aquarium from Gravesend bay May 13, 1896, and was alive and in good condition in November 1898.

Dr Smith records the occurrence of the species along with the common sturgeon at Woods Hole Mass., but says it is less numerous. It is captured in the traps.

Order RHOMBOGANOIDEA

Gar Pikes

Family LEPISOSTEIDAE

Gar Pikes

Genus LEPISOSTEUS Lacépède

Body elongate, subcylindric, covered with hard, rhombic ganoid scales or plates which are imbricated in oblique series running downward and backward; both jaws more or less elon-

gate, spatulate or beaklike, the upper jaw projecting beyond the lower; premaxillary forming most of the margin of the upper jaw; maxillary transversely divided into several pieces; upper jaw with an outer series of small, sharp, even teeth, then a series of large teeth, some of the anterior teeth being usually movable; next a series of fine teeth, in one row in front, becoming a band behind. In some species the inner row of these teeth contains larger ones; next the vomerine teeth, also in a long band, and posteriorly a palatine band. These bands on the roof of the mouth are frequently somewhat confluent or irregular. In young specimens some of the palatine teeth are often enlarged, these sometimes forming regular series. Lower jaw with an outer series of small teeth, next a series of large teeth, next again a broad band of fine teeth on each side. Each of the large teeth fits into a depression in the opposite jaw. Pharyngeals with rasplike teeth; tongue toothless, short, broad, emarginate, free at tip; external bones of skull very hard and rugose; eyes small; nostrils near the end of the upper jaw; an accessory gill on the inner side of the opercle; pseudobranchiae present; no spiracles; gills four, a slit behind the fourth; branchiostegals three; gill membranes somewhat connected, free from the isthmus; gill rakers very short; air bladder cellular, lunglike, somewhat functional; fins with fulcrums; dorsal fin short, rather high, posterior, nearly opposite the anal, which is similar in form; tail heterocercal, in the young produced as a filament beyond the caudal fin; caudal convex; ventrals nearly midway between pectorals and anal; pectorals and ventrals moderate, few-rayed; stomach not caecal; pyloric appendages numerous; spiral valve of intestines rudimentary.

Fishes of the fresh waters of North America and China. (After Jordan and Evermann)

38 Lepisosteus osseus Linnaeus

Gar Pike; Billfish

Esox osseus Linnaeus, Syst. Nat. ed. X, 313, 1758; Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 444, 1815; Am. Month. Mag. II, 321, 1818.

Lepisosteus bison De Kay, N. Y. Fauna, Fishes, 271, pl. 43, fig. 139, 1842.

Lepidosteus osseus GÜNTHER, Cat. Fish. Brit. Mus. VIII, 1870; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 91, 1883.
Lepisosteus osseus JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 109, 1896.

The garpike has an elongate, subcylindric body. Its depth is contained about 12 times in the length without the caudal. The jaws are greatly produced, the upper being the longer. The length of the head is one third of the total without caudal. Teeth in the jaws rather fine, sharp and stiff; a single inner row of large teeth, and an outer row of small teeth on each side. The snout is more than twice as long as the rest of the head, its least width being from one fifteenth to one twentieth of its length. D. 7 to 8; A. 9; V. 6; P. 10. Scales 62 to 65.

Color greenish; the sides silvery and the belly whitish; numerous round, dark spots on the sides, most distinct posteriorly and most conspicuous in the young, becoming obscure with age. Very young individuals have a blackish lateral band. The fins are generally plain, but the vertical fins have numerous round dark spots.

The specimen described is no. 36098, U. S. National Museum. Its length is 24 inches.

This is the common long-nosed gar pike of the Great lakes, the Mississippi valley and the eastern states from Pennsylvania to South Carolina. It ranges south to Mexico and west to the plains. Additional names for the species are: billfish, swordfish, bony gar, bony pike, alligator, alligator gar, and buffalo fish. Prof. Cope recognizes two varieties of this gar in Pennsylvania. One of these abounds in the Susquehanna and the lower Delaware. He distinguishes it by its robust form, short face and gill covers and the roughened scales of the front part of the body. The other variety occurs in lakes and in the Allegheny river and is to be known by its slenderer face and gill covers, its smaller size, generally smooth scales and the absence of dark spots on the body and fins. It should be remembered, however, that the species is extremely variable in these particulars, and all of the names based on such characters have been generally discarded.

The garpike attains to a length of 5 to 6 feet, of which the head and snout usually form about one third. The body is comparatively slender, equaling about one twelfth of the entire length.

This species is more abundant in the Great lakes and large streams than in the small rivers. It is emphatically a fish of prey and extremely tenacious of life. It spawns in shoal water or in the streams, in the late spring and early summer months. Occasionally taken from the northern end of Cayuga lake, but not so numerous as formerly.

The garpike is said to be nowhere used for food, because its flesh is tough and is believed to be unwholesome. I have seen it, however, with the bill cut off and the skin removed, offered for sale in the market at Washington D. C.

39 Lepisosteus platostomus Rafinesque

Short-nosed Gar

Lepisosteus platostomus Rafinesque, Ichth. Ohien. 72. 1820; Kirtland Bost. Jour. Nat. Hist. IV. 20. 1844; Jordan & Evermann, Bull. 47 U. S. Nat. Mus. 110, pl. XXII. fig. 40. 1896.

Lepidosteus platystomus Gunther, Cat. Fish. Brit. Mus. VIII. 329, 1870 Jordan & Gilbert, Bull 10. U. S. Nat. Mus. 91. 1883.

Lepisosteus platyrhinus De Kay, N. Y. Fauna. Fishes. 273, pl. 43, fig. 137 1842.

The short-nosed garpike has an elongated body, its depth being contained seven and one half times in the length; the length of the head is less than one third of the length of body to base of tail; distance from eye to tip of snout greater than from eye to posterior edge of opercle; upper jaw slightly longer than the lower; both jaws with many long, sharp teeth. Dorsal and anal fins placed far back, near the tail; ventrals in middle of length. D. 8; A. 9. About 55 rows of scales between head and caudal. Fins all more or less black spotted. The specimen described no. 3241, U. S. National Museum, from Cleveland O., is 12 inches long.

The short-nosed gar, because of its shorter snout, which even in young specimens does not much exceed the rest of the head in length, has been considered as representing a separate sub-genus, Cylindrosteus of Rafinesque.

This fish seldom exceeds 3 feet in length. Its habits are presumably the same as those of the long-nosed gar, and it is equally worthless for food. It may be readily distinguished from the long-nosed species by the shape of its snout and by its more robust form.

The short-nosed gar inhabits the Great lakes and the Ohio and Mississippi valleys. It is more abundant in the southern part of its habitat. It was not recorded from waters of New York by either Mitchill or De Kay.

Order CYCLOGANOIDEA

Bowfins

Family AMIIDAE

Bowfins

Genus AMIA Linnaeus

Body oblong, compressed behind, terete anteriorly; head subconical, anteriorly bluntish, slightly depressed, its superficial bones corrugated and very hard, scarcely covered by skin; snout short, rounded; lateral margins of upper jaw formed by the maxillaries, which are divided by a longitudinal suture; jaws nearly even in front; cleft of the mouth nearly horizontal, extending beyond the small eye; lower jaw broad, U-shaped, the rami well separated; between them a broad bony plate, with radiating striae, its posterior edge free; jaws each with an outer series of conical teeth, behind which in the lower is a band of rasplike teeth; bands of small teeth on the vomer and pterygoids; palatines with a series of larger, pointed teeth; premaxillaries not protractile; tongue thick, scarcely free at tip; nostrils well separated, the anterior with a short barbel; suborbital very narrow; a bony plate covering the cheek, similar to the plates on the top of the head; operculum with a broad dermal border; branchiostegals 10 to 12; no pseudobranchiae or opercular gill; no spiracle; gills four, a slit behind the fourth; gill membranes not connected, free from the isthmus; two peculiar, long, lanceolate, obliquely striate appendages on each side of the isthmus, projecting backward and covered by the branchiostegal rays,

the anterior wholly adnate to the isthmus, the posterior free behind; isthmus scaleless; gill rakers stoutish, very short; scales of moderate size, rather firm, cycloid, with a membranous border; lateral line present; dorsal fin long and low, nearly uniform; the posterior rays not much higher than the others; tail somewhat heterocercal (more so in the young), convex behind; no fulcrums; anal fin short and low; pectoral and ventral fins short and rounded, the ventrals nearer anal than pectorals; vertebrae amphicoelian or double concave, as usual among fishes, none of them specially modified; abdominal and caudal parts of the vertebral column subequal; air bladder cellular, bifid in front, lunglike, connected by a glottis with the pharynx, and capable of assisting in respiration; stomach with a blind sac; no pyloric caeca; no closed oviduct; intestine with a rudimentary spiral valve. Fresh waters of the United States. (After Jordan and Evermann)

40 Amia calva Linnaeus

Bowfin; Mudfish

Amia calva Linnaeus, Syst. Nat. ed. XII, 500, 1766; Günther, Cat. Fish. Brit. Mus. VIII, 325, 1870; De Kay, N. Y. Fauna, Fishes, 270, 1842; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 94, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 113, 1896; Dean, 4th Ann. Rep't, N. Y. Comm. Fish, Game, Forests, 246-56, pl. ♂ & ♀ and fig. I–VIII, 1899.

Amia occidentalis De Kay, N. Y. Fauna, Fishes, 269, pl. XXXIX, fig. 125, 1842.

The mudfish has a well rounded, robust body; head more or less conical; top covered with hard bony plates; body entirely covered with cycloid scales. The mouth is large; maxilla extending far past eye. Depth of body equals three fourths of length of head and is contained slightly more than five times in length of body. Distance from tip of snout to origin of dorsal equals one third of the total length including tail, the dorsal fin beginning over the end of pectoral; length of dorsal base equal to twice length of head; anal base very short, nearly one third of length of head. Strong conical teeth in the jaws; in the lower jaw there is a band of finer teeth behind the outer row

of large ones. The vomer, palatine and pterygoid bones are finely toothed. A small barbel at anterior nostril. Lateral line continuous; through 62 scales. There are seven rows of scales between dorsal and lateral line and 11 or 12 from lateral line to ventral. D. 50; A. 10 or 11.

The color in life is dark olive, the sides with greenish reticulations, the belly whitish; round dark spots on the lower jaw and gular plate. The male has a roundish black spot with an orange border at the base of the caudal fin.

The bowfin has various common names, among them mudfish, dogfish, lawyer, grindle, and John-a-grindle. Its range is as extensive as its character is generally worthless. It is found in the Great lakes and tributary streams, in the Ohio and Mississippi valleys southward to Texas, and in eastern waters from Pennsylvania to Florida.

The female bowfin is larger than the male, reaching a length of 2 feet, while the male seldom exceeds 18 inches. The male is still further distinguished by the presence of a large black spot or spots, margined with orange or crimson, at the base of the tail fin. The female also has the caudal spot, but very faintly developed. The greatest recorded weight of this fish is 12 pounds.

Habits. This is one of the most voracious of all fishes. It feeds on all other fish of suitable size and also destroys other animals within reach. The capture of the bowfin by means of the trolling spoon has recently come into greatly increased favor with anglers because of the game qualities of the fish and its wonderful tenacity of life. The species has been known to live out of the water, exposed to the sunlight, 12 hours or more. The young may be kept in an aquarium or other receptacle without change of water for months. The spawning season of the bowfin is in May and June, and stagnant sloughs are favorite localities for this purpose. The eggs and young are protected by the parents, and the young remain in the pools after the falling waters cause the departure of the adults. Dr Estes, who has made the best observations on the reproduction of this

species, states that the little ones are protected in the mouth of the parent when suddenly alarmed. The jumping of the bowfin is one of its most characteristic habits. Dr Estes saw them turn complete somersaults while in the air.

The bowfin is not a food fish, its flesh being soft and unsavory; yet Dr Goode found them highly esteemed as a sweet morsel by the negroes of the south. The young are in great demand as bait for pike and pickerel, and both these and the adults are interesting for the aquarium because of their colors, the ease with which they endure captivity, the peculiarities of their anatomic structure and their affinities with extinct ganoids.

It is seldom taken near Ithaca and is not common at the northern end of Cayuga lake.

Series TELEOSTEI

Bony Fishes

Subclass OSTARIOPHYSI

Order NEMATOGNATHI

Catfishes

Family SILURIDAE

Catfishes

Genus FELICHTHYS Swainson

Body rather elongate, little compressed; head depressed, broad above; mouth large, the upper jaw the longer; teeth all villiform, those on the vomer and palatines forming a more or less perfectly crescent-shaped band; barbels four; maxillary barbels bandlike, very long; two short barbels on chin; nostrils close together, the posterior with a valve; nuchal region with a granulated, bony buckler; fontanelle large, well forward; gill membranes somewhat connected; dorsal fin short, in front of ventrals, with one sharp spine and seven rays; pectorals with a similar spine; pectoral spines, and sometimes dorsal spines also, ending in a long, striated, bandlike filament; anal fin emarginate, shorter than caudal part of vertebral column; adipose fin mod-

erate, free behind; caudal fin widely forked; ventral rays six. Species all marine; in tropical American waters.

41 Felichthys marinus (Mitchill)

Sea Catfish; Gaff Topsail

Silurus marinus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 433, 1815.
Galeichthys marinus De Kay, N. Y. Fauna, Fishes, 178, pl. 37, fig. 118, 1842.
Ælurichthys marinus Günther, Cat. Fish. Brit. Mus. V, 178, 1864; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 111, 1883.
Felichthys marinus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 118, pl. XXIII, fig. 52, 1896; Smith, Bull. U. S. F. C. XVII, 90, 1898.

Body somewhat compressed, moderately elongate, its depth at dorsal origin two ninths of length to base of middle caudal rays; caudal peduncle slender, its least depth little more than one third of greatest depth of body; head short, snout rounded, length of head one fourth of total length to base of middle caudal rays; occipital buckler small, oblong, nearly uniform in breadth; band of palatine teeth nearly continuous, variable; maxillary barbel, pectoral fin and dorsal fin about equal in length; eye oblong, small, one fifth length of head; snout about one fourth of length of head; maxillary barbel reaches nearly to ventral origin; pectoral filament about to vent; dorsal, when laid back, almost to adipose fin; ventral origin slightly nearer tip of snout than base of middle caudal rays; caudal lobes unequal, the upper two sevenths of length to middle caudal rays, the lower as long as the head; adipose fin small, one third higher than wide, its length contained three and two thirds times in that of head; anal base one sixth total length to base of middle caudal rays, longest anal ray two and one third times in head; ventral one half as long as head. D. I, 7; A. 23 (16 developed); P. I, 12; V. I, 5; B. 6. Vetebrae 20 + 30. Color, glossy bluish above, silvery or milk white below.

The sea catfish is found from Cape Cod to Texas; common southward. Mitchill says it "is an exquisite fish for eating;" but the species is generally not valued for food. De Kay also was informed by persons who had eaten it that the fish has an exquisite flavor. He states that it is frequently abundant in

Communipaw creek, on the Jersey side of the harbor of New York. It swims frequently with its long dorsal above the surface, in the manner of sharks, and imitates those animals in voracity. Mitchill had a specimen 20 inches long.

At Woods Hole Mass., according to Dr Smith, the species is quite rare, and few have been seen recently; one was caught in a trap at Menemsha in 1886.

Genus HEXANEMATICHTHYS Bleeker

Body moderately elongate, subterete; head depressed, armed with a bony shield above, behind which projects an occipital shield; a smaller, crescent-shaped shield at the base of the dorsal spine; these shields usually exposed but sometimes covered by the skin; skull with a fontanel; mouth moderate, the upper jaw the longer; teeth villiform or granular, in a band in each jaw; teeth in one or two patches each on the vomer and palatines, the palatine patches without a backward projecting angle on the inner margin; palatine teeth fixed; barbels six (no nasal barbels), close together, the posterior with a valve; maxillary barbels short, terete; eyes with a more or less free orbital margin, the upper edge sometimes adnate; dorsal fin short, in front of the ventrals, with a sharp spine and about seven rays; adipose fin well developed, posteriorly free; caudal fin deeply forked; anal fin short; pectorals with spine; ventral rays six; skin smooth, naked, except on the occipital and nuchal regions, where it is usually confluent with the surface of the bony bucklers. Species marine.

42 Hexanematichthys felis (Linnaeus)

Sea Catfish

Silurus felis LINNEAUS, Syst. Nat. ed. XII, 503, 1766.
Arius milberti GÜNTHER, Cat. Fish. Brit. Mus. V, 155, 1864.
Arius equestris GÜNTHER, l. c. 173, 1864; BAIRD & GIRARD, Ichth. U. S. & Mex. Bound. 32, pl. 15, 1859.
Arius felis and *equestris* JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 110, 1883.
Galeichthys felis SMITH, Bull. U. S. F. C. XVII, 90, 1898.
Hexanematichthys felis JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 47, 128, pl. XXIII, fig. 53, 1896.

Body tapering, elongate, terete, its depth at dorsal origin one fifth of length to base of middle caudal rays; caudal peduncle short, its least depth two fifths of greatest depth of body; head rather elongate, pointed, its length contained three and two thirds times in total to base of middle caudal rays; occipital process with a median keel, about one third of length of head, its tip convex; fontanel forming a narrow groove; top of head comparatively smooth; maxillary barbel three fourths as long as the head; longest mental barbel little more than one half of length of head; eye oblong, placed high, its length one half the length of snout, which is one third the length of head; dorsal origin somewhat behind middle of pectoral fin; dorsal base about equal to snout, highest ray slightly exceeds greatest depth of body; pectoral fin reaches about to below end of dorsal base; ventral origin midway between tip of snout and end of middle caudal rays, length of fin two and one third times in head. Distance from vent to anal origin equals longest anal ray. Length of anal base equals one half the length of head. Caudal lobes unequal, the upper one fourth longer than lower. D. I, 7; P. I, 6; A. 16 (13 developed); V. I, 5.

Color steel blue, sides and belly silvery, lower parts pale. Cape Cod to Texas; common southward along the sandy coast.

Cuvier and Valenciennes received a specimen from New York, forwarded by Milbert. Of its occurrence at Woods Hole Mass. Dr Smith made the following record: "Reported to have been common in spring in Vineyard sound many years ago, being often taken with cod; now (1898) very rare, and only occasionally observed since the fish commission station at Woods Hole was established. A specimen was taken in 1887; since which time none has been reported."

Genus ICTALURUS Rafinesque

Body slender, elongate, compressed posteriorly; head slender, conical; superoccipital bone or process prolonged backward, its emarginated apex receiving the acuminate anterior point of the second interspinal, thus forming a continuous bony bridge from

the head to the dorsal spine; mouth small, terminal, the upper jaw longer; teeth subulate, in a short band on each jaw; dorsal fin high, with one long spine and usually six rays; adipose fin over posterior part of anal; anal fin long, with 25 to 35 rays; ventral fins each with one simple and seven branched rays; pectoral fins each with a stout spine, retrorse serrate within, and about nine rays; caudal fin elongate, deeply forked, the lobes pointed, the upper the longer. Coloration pale or silvery, usually with dark spots on the sides. Fresh waters of North America, specially in river channels and ripples in large streams.

43 Ictalurus punctatus (Rafinesque)

Channel Cat; Spotted Cat

Silurus punctatus RAFINESQUE, Am. Month. Mag. 359, Sept. 1818, *fide* Jordan.

Ictalurus punctatus JORDAN, Bull. Buffalo Soc. Nat. Hist. 95, 1876; Man. Vert. 300, 1876; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 108, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 134, pl. XXV, fig. 58, 1896.

Amiurus cauda-furcatus GÜNTHER, Cat. Fish. Brit. Mus. V, 102, 1864.

The body of the spotted catfish is rather long and slender, the depth contained five times in the length without caudal and equal to the length of the dorsal spine. The head is moderate, convex above, its length being slightly less than one fourth the total length. The maxillary barbels are very long, longer than head; eye moderate, five and one half in head; pectoral spine two thirds of length of head; humeral process long and slender, one half the length of pectoral spine; adipose fin well developed; caudal deeply forked. The least depth of the caudal peduncle equals one half the depth of body at last dorsal ray. D. I, 6; A. 24; V. I, 8.

This species is variously styled the channel cat, white cat, silver cat, blue cat and spotted cat. It is found over a vast extent of country comprising the Mississippi and Ohio valleys and the Great lakes region. In the eastern states it is absent from streams tributary to the Atlantic, but occurs from Vermont southward to Georgia, westward to Montana and southwestward to Mexico. In Pennsylvania it is limited to the Ohio and its affluents.

The adults of this species are bluish silvery, and the young are spotted with olive. It is one of the handsomest of the family of catfishes and an excellent food fish. The spotted cat grows to a length of 3 feet and a weight of 25 pounds. It is extremely variable in color and in number of fin rays, and has, consequently, been described under more than 20 different names. It is most abundant in large clear streams. This species is less hardy than most of the other catfishes.

Genus AMEIURUS Rafinesque

Body moderately elongated, robust anteriorly, the caudal peduncle much compressed; head large, wide, obtuse; supero-occipital extended backward, terminating in a more or less acute point, which is entirely separate from the second interspinal buckler; skin covering the bones thick; eyes rather small; mouth large, the upper jaw usually the longer; teeth in broad bands on the premaxillaries and mandibles; band of upper jaw convex in front, of equal breadth, and without backward prolongation at the angle; dorsal over the space between pectorals and ventrals, higher than long, with a sharp spine and about six branched rays; adipose fin short, inserted over the posterior half of the anal; anal fin usually short, with 20 or 21 rays, but varying from 15 to 35 if certain fork-tailed species really belong to the genus; caudal fin short, truncate in typical species, more or less forked in forms approaching Ictalurus; ventrals with one simple and seven branched rays; pectoral fins each with a stout spine, which is commonly retrorse serrate behind; lateral line usually incomplete; species numerous in nearly all fresh waters of the eastern United States.

44 **Ameiurus lacustris** (Walbaum)

Lake Catfish

Gadus lacustris WALBAUM, Artedi, Gen. Pisc. 144, 1792.
Amiurus borealis GÜNTHER, Cat. Fish. Brit. Mus. V, 100, 1864.
Ictalurus lacustris JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 108, 1883.
Ictalurus nigricans JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 882, 1883.
Pimelodus nigricans DE KAY, N. Y. Fauna, Fishes, 180, pl. 62, fig. 170, 1842.
Ameiurus lacustris JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 137, 1896.

The great catfish has a stout body, a broad and much depressed head and a wide mouth. The depth of the body is contained five times in total length, without caudal; the head equals more than one fourth of this length. Maxillary barbel as long as anal base, almost as long as the head; eye rather small; dorsal base short, one half the hight of fin; adipose fin well developed; caudal not deeply forked; pectoral spine as long as dorsal spine, one half the length of head; least depth of caudal peduncle less than one half the greatest depth of body. D. I, 5 to 6; A. 25; V. I, 8.

This is the great fork-tailed cat, Mississippi cat, Florida cat, flannel-mouth cat and great blue cat of various writers. It is also called mud cat in the St Johns river, Fla. The species is highly variable, as we should suppose from its wide distribution.

In 1879 Prof. Spencer F. Baird received from Dr Steedman of St Louis a Mississippi river catfish weighing 150 pounds and measuring 5 feet in length. The writer described this fish as a new species related to the great black catfish of the Mississippi valley, A m i u r u s n i g r i c a n s. At the present time it is somewhat doubtful whether or not this is merely an overgrown individual of the species under consideration, and the matter must remain in doubt till smaller examples of A m i u r u s p o n d e r o s u s have been obtained.

The great fork-tailed cat is a native of the Great lakes and the Ohio and Mississippi valleys, and in the southern states its range extends southward to Florida; northward it ranges to Ontario.

This catfish reaches a weight of 100 pounds or more, and, if it include the giant form above referred to, we may place the maximum weight at more than 150 pounds. Dr Steedman was informed by an old fisherman that the heaviest one he had ever seen weighed 198 pounds, but it is doubtful that such large individuals are to be taken at the present time. In Lake Erie this species usually weighs from 5 to 15 pounds, and the largest specimens reach 40 pounds.

The habits of this fish are presumably about the same as those of other species of the family. On account of the great size of the fish it naturally prefers lakes and large rivers. It is a bottom feeder and will take almost any kind of bait. This species is wonderfully tenacious of life. It spawns in the spring and protects its young, which follow the parent fish in great schools. Dr Theodore Gill has reviewed in *Forest and Stream* the subject of the catfishes' care of their young.

This is a valued food species, though not a choice fish. In Lake Erie, according to the *Review of the Fisheries of the Great Lakes* recently published by the U. S. Fish Commission, the catfish rank next to whitefish in number of pounds taken.

In Lake Erie catfish are taken chiefly by means of set lines, and the fishing is best during the months of June, July and August. The method of fishing is thus described in the review just referred to. "The apparatus consists of from 200 to 400 hooks attached by short lines to a main line, which is from 5 to 27 fathoms long, according to the place in which set, and is held in place by poles or stakes pushed into the mud. The lines are usually set in the lake, but occasionally short ones are fished in the bayous and marshes. Catfish are taken with a bait of herring, Coregonus artedi, or grasshoppers, and are mostly used in the families of the fishermen and their neighbors or sold to peddlers. . . The size of the catfish ranges from 5 to 25 pounds, averaging 8 or 10 pounds." In some parts of Lake Erie the set line fishery for catfish begins April 15. Some of these lines have as many as 2000 hooks. In Toledo these fish bring 4½c a pound. The pound nets also take a good many catfish in the spring and fall. Erie receives its supply of catfish from fishermen who operate in the lake from Erie to Elk Creek with set lines during the summer months. De Kay had the species from Buffalo, where he saw specimens weighing from 25 to 30 pounds, and heard of individuals weighing 80 pounds. He states that it is usually captured by the spear.

45 Ameiurus natalis (Le Sueur)

Yellow Cat

Pimelodus natalis Le Sueur, Mém. Mus. d'Hist. Nat. V, 154, 1819.
Pimelodus cupreus De Kay, N. Y. Fauna, Fishes, 187, 1842. (name only)
Amiurus natalis Günther, Cat. Fish. Brit. Mus. V, 101, 1864; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 105, 1883.
Ameiurus natalis Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 139, 1896.

The yellow catfish is robust, and has a rather broad head. The mouth is wide, with the upper jaw usually longer than the lower, sometimes equal. The dorsal profile gradually ascends from the snout to the dorsal spine. The depth of the body at dorsal spine is contained four and two third times in the total length to base of tail. The length of the head is contained three and two third times in the body length, and equals length of anal base. Eye moderate; maxillary barbel reaching end of head; humeral shield little developed; dorsal and pectoral spines strong, shorter than soft rays; hight of dorsal equal to twice the length of its base; adipose fin long as in Noturus, opposite to and longer than anal; caudal rounded. D. I, 6; A. 24; V. I., 8.

The yellow cat, or chubby cat, is found from the Great lakes to Virginia and Texas. It has many varieties; three of which are mentioned by Prof. Cope as occurring in Pennsylvania, two of them in the Ohio river and its tributaries and the third in Lake Erie. The species is not credited to the region east of the Alleghanies. Dr Meek saw only a single specimen from Cayuga lake.

The length of the yellow cat sometimes reaches 2 feet but averages much less.

Nothing special is recorded about the habits of this species. It is most abundant in sluggish streams.

46 Ameiurus vulgaris (Thompson)

Long-jawed Catfish

Pimelodus vulgaris Thompson, Hist. Vermont, 138, 1842.
Amiurus vulgaris Nelson, Bull. Ills. Mus. Nat. Hist. 50, 1876; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 105, 1883.
Amiurus dekayi Jordan, Man. Vert. 302, 1876; Goode, Fish. & Fish. Ind. U. S. I, pl. 234, 1884; Bean, Fishes Penna. 15, pl. 18, fig. 24.

Ameiurus vulgaris JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 140, 1896.

This catfish has a stout body; its depth is one fourth of the total length without caudal. The head is contained about three and three fourth times in this length. Eye very small; mouth large; jaws equal or sometimes lower jaw projecting; barbels long; maxillary barbel as long as head. The length of the dorsal base is less than one half that of the anal, while its hight is five sixths of the same length; adipose fin well developed. The pectoral spine is stout and about two thirds as long as the fin. Caudal square; anal rounded; least depth of caudal contained two and one third times in greatest depth of body. D. I, 6; A. 18 (20); V. I, 8.

The long-jawed catfish is found in the Great lakes region and westward to Manitoba. It is believed to be very nearly related to the common catfish, A. nebulosus, but its projecting lower jaw will serve to distinguish it. This character, however, we know by experience is not so satisfactory as it might be.

The species reaches the length of 18 inches and the weight of 4 pounds. It is occasionally taken in the Ohio river, but is more abundant in Lake Erie. Jordan and Evermann state its range to be from Vermont to Minnesota and Illinois, chiefly northward. The U. S. National Museum has it from Manitoba. Dr Meek found a single specimen which was caught near Ithaca among more than 100 of the common bullheads. It seems to be rare in that basin. Thompson, who described the fish, had specimens from Lake Champlain. The long jawed catfish is similar in all respects except its projecting lower jaw to the common catfish, A. nebulosus, and may be found identical with it.

47 Ameiurus catus (Linnaeus)

White Cat; Channel Cat

Silurus catus LINNAEUS, Syst. Nat. ed. X, 305, 1758.
Pimelodus atrarius DE KAY, N. Y. Fauna, Fishes, 185, pl. 36, fig. 116, 1842.
Ictalurus albidus JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 107, 1883.
Ictalurus lophius JORDAN & GILBERT, l. c. 107, 1883.

Amiurus albidus JORDAN, Bull. 10, U. S. Nat. Mus. 84, 1877, figs. 15 & 16, 1877; BEAN, Fishes Penna. 14, pl. 18, fig. 23, 1893.
Amciurus catus JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 138, 1896.

The body is stout, its depth equal to length of head, and contained four times in the total length to base of caudal fin. The maxillary barbels reach posterior end of head; mandibulary barbels shorter; humeral process, above pectoral, half length of pectoral spine, very rough; dorsal fin short, inserted nearly midway between tip of snout and adipose dorsal; adipose fin well developed; caudal fin slightly forked, the upper lobe longer; anal fin long, one fifth to one fourth of total length to base of caudal. D. I, 6; A. 19 to 22. Pale olive bluish, silvery below without dark spots, but sometimes with mottlings or blotches. New York to Texas, in coastwise streams and swamps. Introduced into California and now abundant there.

This is the white cat or channel cat, in Philadelphia distinguished as the Schuylkill cat. The channel cat is one of the most abundant of its family in the Potomac river. It is abundant in the Susquehanna and common in the Schuylkill.

This species reaches a length of 2 feet and a weight of 5 pounds. It is extremely variable with age. Old examples have the mouth so much wider than it is in the young that they have been described as a distinct species. The big-mouthed cat of Cope is now considered to be the old form of the white cat. The habits of this species agree with those of other species already mentioned. The name channel cat suggests a favorite haunt of the fish.

As a food fish it is highly prized.

Eugene Smith[1] says this catfish occurs in all the larger streams subject to the tide in the vicinity of New York city. The caudal is furcate. The anal has 20 or more rays.

It is frequently caught on set lines with liver or killy bait and bites best at night. The flesh is much better flavored than that of A. nebulosus.

[1]Linn. Soc. N. Y. Proc. 1897. no. 9, p. 11.

48 Ameiurus nebulosus (Le Sueur)

Horned Pout; Bullhead

Pimelodus nebulosus Le Sueur, Mém. Mus. d'Hist. Nat. V, 149, 1819.
Pimelodus catus De Kay, N. Y. Fauna, Fishes, 182, pl. 37, fig. 119, 1842.
Amiurus catus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 104, 1883.
Silurus catus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 433, 1815. (not *Silurus catus* Linnaeus)
Amiurus nebulosus Bean, Fishes Penna. 16, pl. 19, fig. 25, 1893.
Ameiurus nebulosus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 140, 1896.

The common catfish has a very stout body, broad head and a short stout caudal peduncle. The depth of body about equals length of head, and is contained from three and one half to four and one half times in the length. Barbels eight; maxillary barbels as long as head; dorsal profile from tip of snout to dorsal fin straight and rather steep; mouth wide and terminal; teeth awl-shaped, in broad bands on the intermaxillaries and dentaries; dorsal situated in front of middle of body; short and high; adipose fin stout; anal large, its base equaling length of head; caudal square or slightly emarginate. D. I, 6; A. 20-22; P. I, 6.

This is known as the common catfish, bullhead, hornpout, bullpout, and minister.

This species has a wider distribution than the white cat, its range including New England and extending southward to South Carolina, west to Wisconsin and southwest to Texas. It has also been transferred from the Schuylkill to the Sacramento and San Joaquin rivers, Cal. where it has multiplied so rapidly that it is now one of the most common fishes of those streams. This is the most abundant catfish in Lake Erie and its tributaries.

The species reaches a maximum length of 18 inches and a weight of 4 pounds, but the average size of market specimens is much smaller. In the lower waters of the Susquehanna color varieties of this species are not uncommon. One of them appears to be the same as the Amiurus marmoratus of Holbrook; this supposed color variety is found also from Illinois to Florida. The lower Susquehanna has furnished also some singularly colored examples of this fish, distinguished by

large areas of jet black combined with lemon and white. These freaks are among the most interesting and beautiful observed in this family of fishes.

From Jordan's *Manual of the Vertebrates* I quote Thoreau's account of the habits of this species:

The horned pout are "dull and blundering fellows," fond of the mud, and growing best in weedy ponds and rivers without current. They stay near the bottom, moving slowly about with their barbels widely spread, watching for anything eatable. They will take any kind of bait, from an angleworm to a piece of a tin tomato can, without coquetry, and they seldom fail to swallow the hook. They are very tenacious of life, "opening and shutting their mouths for half an hour after their heads have been cut off." They spawn in spring, and the old fishes lead the young in great schools near the shore, seemingly caring for them as the hen for her chickens.

The species was obtained in Swan river at Patchogue N. Y. Aug. 12, 1898. Young were seined in Bronx river in August. Larger individuals were sent from Canandaigua lake and Saranac lake in November. Several albinos were obtained from the Hackensack meadows, N. J., in August 1897. In three months they grew from 3 inches to 6 inches in length. In captivity the fish feed freely on chopped hard clams and earthworms and, occasionally, liver.

The following notes are from Eugene Smith, in Proc. Linn. Soc. N. Y. 1897, p. 11-12.

Very variable in color, from dark blackish and olive to brown and yellowish above, becoming lighter below, and often clouded on the sides. Those from tidal or running water are lighter colored than those from stagnant places or ponds.

The largest specimen found by me in the near vicinity of New York measured 13½ inches in length and weighed 1 pound 2 ounces.

At the end of the third year this fish is perhaps fully matured. The ripe eggs are of the size of large pin heads and are of an orange color; the very young fishes look like little black toad tadpoles. The spines are strongly developed at an early age. The old fish accompanies the brood for a certain time, always swimming around the swarm of young in order to keep them together. When alarmed the parent dashes off, followed by the whole swarm.

Dr Meek found the species very abundant throughout the entire Cayuga lake basin. Dr Evermann and Barton A. Bean obtained the following specimens in the St Lawrence river basin in 1894.

1, St Lawrence river, Cape Vincent N. Y. June 21.

3, Racket river, Norfolk N. Y. July 18.

Dr Evermann also collected specimens at the following localities of the Lake Ontario region in 1894.

Stony creek, Henderson Harbor, July 3, 4
Black river, Huntingtonville, July 5
Mud creek, Cape Vincent, June 25
Mouth Salmon river, July 25
Chaumont river, July 10
Creek, Pultneyville, Aug. 7
Mouth Little Salmon creek, July 25
Sandy creek, North Hamlin, Aug. 20
Long pond, near Charlotte, Aug. 17
Stony Island, July 2, 3
Lakeview hotel, 7 m. n. e. of Oswego, July 17
Marsh creek, Pointbreeze, Aug. 21

49 Ameiurus nebulosus marmoratus (Holbrook)

Marbled Cat

Pimelodus marmoratus Holbrook, Jour. Ac. Nat. Sci. Phila. 54, 1855.
Amiurus marmoratus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 104, 1883.
Ameiurus nebulosus marmoratus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 141, 1896.

Body moderately elongate, its depth about one fourth total length to caudal base; slope of profile very steep; jaws equal or subequal; dorsal fin high, its spine more than one half as long as head, and nearer to adipose fin than to tip of snout; head long, three and one fourth times in total length to caudal base; barbels long; anal rays 21; body much mottled with brown, greenish and whitish. Lowland streams and swamps from New York to southern Indiana and Florida. The type of the marmoratus of Holbrook was from South Carolina.

50 Ameiurus melas (Rafinesque)

Black Bullhead; Brown Catfish

Silurus melas Rafinesque, Quart. Jour. Sci. Lit. Arts. Lond. 51, 1820.

Pimelodus pullus De Kay, N. Y. Fauna, Fishes, 184, pl. XXXVII, fig. 117. 1842.

Amiurus pullus Gill, Proc. Bost. Soc. Nat. Hist. 44, 1862; Jordan, Bull. 10. U. S. Nat. Mus. 93, figs. 46, 47, 1877; Goode, Fish. & Fish. Ind. U. S. I, pl. 233, fig. 1, 1884; Bean, Fishes Penna. 16, 1893.

Ameiurus melas Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 141, 1896.

The body of the black bullhead is stout, short and deep. Its depth is contained about three and one half times in its length to tail; in very deep examples but three and one fifth times. The length of the head is contained three and one half times in this length. The head is broad, the dorsal profile straight and rather steep from tip of snout to dorsal fin; eye rather small; barbels long; caudal peduncle stout. Dorsal I, 6; the spine strong and sharply pointed. The hight of the dorsal fin equals one half the length of head. The anal has 18 rays; its base is two and one half times as long as dorsal base. The pectoral fin has one sharp spine and seven rays. Tail truncate; adipose fin well developed; teeth very fine, awl shaped and in broad bands. Its color is usually blackish or dusky brown, approaching to black, while the lower parts are bluish white. The fins are black, tinged with red, and the barbels are black. The color is subject to considerable variation. The black bullhead reaches the length of 1 foot. It is found in the Great lakes region and in the Mississippi valley, westward to Kansas and southward to Texas.

This species was known to De Kay as the brown catfish. His specimens were from Lake Pleasant and Lake Janet, N. Y.; and he states that it is also very common in many other lakes of northern New York, where its principal use is to serve as bait for the lake trout. Dr Jordan had it from the Genesee river. Dr Evermann obtained a specimen in Mill creek at Sacketts Harbor N. Y. July 2, 1894, and doubtfully referred to this species a young individual collected in Sandy creek, at North Hamlin N. Y. Aug. 20, 1894.

Genus NOTURUS Rafinesque

Body moderately elongate, robust except in caudal part, which is much compressed; head flat and broad; mouth terminal, broad; teeth in broad villiform bands on premaxillaries and dentaries; teeth of upper jaw prolonged backward into an elongate, triangular extension; adipose fin adnate to the back; a poison gland at the base of the pectoral spine. Represented by a single species inhabiting rivers and channels.

51 Noturus flavus Rafinesque

Stone Cat

Noturus flavus RAFINESQUE, Ichth. Ohien. 68, 1820; STORER, Syn. Fish. N. A. 154, 1846; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 100, 1883; GÜNTHER, Cat. Fish. Brit. Mus. V, 104, 1864; BEAN, Fishes Penna. 18, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 144, 1896, pl. XXVII, fig. 63, 1900.

Pimelodus flavus DE KAY, N. Y. Fauna, Fishes, 187, 1842 (after Kirtland).

The stonecat has a moderately elongate body, whose greatest depth and width are nearly equal; the tail is much compressed, and the head flat and broad. The greatest depth of the body is nearly one fifth of the total length without the caudal; the least depth of the caudal peduncle equals nearly one half the length of head. The mouth is terminal, horizontal, its width equal to postorbital part of head and to length of maxillary barbel; longer barbel on chin not quite one half as long as the head. Nasal barbel when laid back reaches end of eye. The width of the band of teeth in the upper jaw equals one third the length of head; the backward prolongation is little longer than the eye. The distance between the eyes equals length of snout and eye. The snout is one half as long as the postorbital part of the head. The dorsal origin is at a distance from tip of snout nearly equal to one third of the total length without caudal. The dorsal base is one half as long as the head. The spine is very sharp and as long as the snout. The longest ray is nearly one half as long as the head. The ventral origin is not far behind the end of the dorsal base; the fin reaches a little beyond the vent, but not to the anal origin. The pectoral reaches to below the third dorsal ray, its spine about two fifths as long

as the head. The anal origin is a little nearer to base of caudal than to origin of pectoral; the base is as long as the head without the snout, one fifth of total to base of caudal, and the longest ray equals one half the length of head. The very low adipose dorsal begins over the anal origin and continues into the caudal; in older specimens it is deeply notched. The caudal is rounded. D. I, 6; A. 16; V. 9; P. I, 9. Length of the specimen described (no. 35877, U. S. national museum), 6¼ inches. In spirits the upper parts are grayish brown, and the lower surface of head and body pale. In life the fish is nearly uniform yellowish brown.

The stonecat is found from Ontario, throughout the Great lakes region, south to Virginia and Texas, west to Montana and Wyoming. It inhabits the larger streams. Dr Evermann obtained two specimens at Nine Mile point, in the Lake Ontario region, June 11, 1893.

The species has very little value as food on account of its small size. It seldom exceeds 12 inches in length, but it is a very good bait for black bass. The stonecats are much dreaded by fishermen because of the painful wounds sometimes produced by their pectoral spines. There is a minute pore in the axil of the pectoral, which is the outlet of a noxious liquid secreted by a poison gland. When this poison is discharged into a wound, it causes an extremely painful sore.

Genus SCHILBEODES Bleeker

Body moderately elongate, rounded anteriorly, compressed posteriorly; head flat; skin very thick, concealing bones of head; superoccipital not joined to the head of the second interspinal; mouth large, anterior, the upper jaw somewhat the longer; awl-shaped teeth in broad bands in the jaws, the band in the upper jaw abruptly truncate at each end and not prolonged into a backward extension as in Leptops and Noturus; branchiostegals nine; dorsal fin nearer to ventrals than to pectorals, with a short spine and seven rays; adipose fin long and low, adnate to the body and continuous with the caudal fin, the adipose membrane sometimes high and continuous, sometimes

emarginate; caudal fin very obliquely truncated or rounded, its base also obliquely rounded; many rudimentary rays both above and below the caudal peduncle; anal fin short with 12 to 23 rays; ventrals rounded; pectoral fins with a sharp spine of varying form; vent well in front of anal fin; lateral line complete. A poison gland opening by an orifice in the axil of the pectoral, so that wounds made by the pectoral spines are very painful. Size small. Fresh waters of the eastern United States among rocks and weeds, specially in small brooks. (After Jordan and Evermann)

52 Schilbeodes gyrinus (Mitchill)

Stone Cat

Silurus gyrinus Mitchill, Amer. Month. Mag. II, 322, March,1818 (Wallkill River, N. Y.); De Kay, N. Y. Fauna, Fishes, 186, 1842 (generic distinction recognized).

Noturus gyrinus Rafinesque, Journ. de Physique, 421, 1819; Ichth. Ohien. 68, 1820; Jordan, Man. Vert. 303, 1876, Bull. 10, U. S. Nat. Mus. 102, figs. 66, 67, 1877; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 98, 1883; Bean, Fishes Penna. 20, 1893.

Schilbeodes gyrinus Bleeker, Act. Soc. Sc. Indo-Nederl. IV, 258, 1858, *fide* Günther, Cat. Fish. Brit. Mus. V, 104, 1864; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 146, 1896.

The tadpole stonecat has a short and stout body, sloping rapidly downward from the dorsal origin to the tip of the snout; its greatest depth contained four and one third times in total length without caudal; its width contained four and one half times. The head is short, broad and depressed, its width nearly equal to its length, which is one fourth of the total without caudal. The width of the mouth equals two thirds the length of the head; the jaws nearly equal. The width of the maxillary band of teeth equals one third of length of head; there are no lateral backward extensions. The snout is short, two sevenths as long as the head. The eye is small, one seventh as long as the head. The maxillary barbel reaches to the base of the pectoral; the outer mandibulary barbel is slightly longer. The nasal barbel is one half as long as the head. The distance of the dorsal from the tip of snout equals that from origin of ventral to end of anal. The base is as long as the snout and eye combined; the spine is one third as long as the head, and the

longest ray equals length of postorbital part of head. The low adipose fin begins over the anal origin and is continuous with the caudal. The ventral origin is under the end of the dorsal base, the fin does not reach to anal origin. The pectoral reaches to below the middle of the dorsal. The anal base is one fifth of total length without caudal; the longest ray equals postorbital part of head. The caudal is rounded. The pectoral spine is one half as long as the head. The humeral process is one third as long as the head. D. I, 6; A. 13–15; P. I, 8. Color in spirits dark brown; the belly and under surface of head paler.

The specimens described (no. 1508, U. S. National Museum) are from 3½ to 4 inches long.

The general color is brownish, without blotches. Jordan in the *Manual* says that it has a black lateral streak, sometimes with two other streaks above this. I have found none with this feature; it is the lateral line itself which looks darker in color.

The eyes are small, beadlike and at night glisten like adamant, indicating a more nocturnal habit. These fishes are called stonecatfishes, but they prefer still, muddy water. In the aquarium it is even more hardy than the common catfish and often lies on its side for hours as if dead, or remains suspended in the water in various odd positions. (After Eugene Smith)[1]

Dr Meek had no knowledge of the occurrence of this species near Ithaca. The museum of Cornell University has a few specimens from the lake, but without definite locality. Dr Meek and Mr Harris took several examples from a small stream near Montezuma. Dr Evermann secured a specimen in Mill creek, at Sacketts Harbor N. Y. July 2, 1841; one in Long pond, at Charlotte N. Y. Aug. 17; and one in Guffon creek, at Chaumont N. Y. July 7 of the same year. In general it ranges in the Great lakes region, through the Mississippi and Ohio valleys, and in New York, Pennsylvania and New Jersey. Its length does not exceed 5 inches. The species is too small to be of any value except for bait, and on account of its tenacity of life it is greatly in demand for hook and line fishing, specially in the capture of the black bass, for which it is one of the best baits known.

[1]Linn. Soc. N. Y. Proc. 1897. no. 9, p. 12-13.

53 Schilbeodes insignis (Richardson)

Margined Stone Cat

Pimelodus insigne Richardson, Fauna Bor.-Amer. III, 132, 1836 (name only, based upon the *Pimelode livrée* Le Sueur, Mém. Mus. d'Hist. Nat. V, 155), 1819.

Noturus lemniscatus Günther, Cat. Fish. Brit. Mus. V, 104, 1864; Jordan, Man. Vert. 303, 1876.

Noturus insignis Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 100, 1883; Bean, Fishes, Penna. 19, pl. 19, fig. 26, 1893.

Schilbeodes insignis Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 147, 1896, pl. XXVIII, fig. 66, 1900.

The margined stone cat has a moderately elongate and low body, its width greater than its depth, and the least depth of the caudal peduncle about three fourths the greatest depth of body. The head is rather long and depressed, one fourth of total without caudal, the snout short and rounded. The eye is small, its length one half the width of interorbital space and little more than one half the length of snout. The lower jaw is slightly shorter than the upper; the width of the mouth equals postorbital part of head. The width of the maxillary band of teeth equals one third the length of head; there is no extension backward. The maxillary barbel reaches nearly to the end of the head. Six short gill rakers below the angle of the first gill arch. The dorsal origin is about over the middle of the space between the pectoral and ventral origins; the length of the dorsal base equals the distance between the eyes, and also the length of its spine. The longest ray is half as long as the head. The ventral reaches beyond the vent and almost to the anal origin, its length half the head. The pectoral does not reach to the ventral origin, its spine half as long as the head, rough along its front edge and coarsely serrate behind. The adipose fin is little developed; it begins over the anal origin and is continuous with the caudal. The anal origin is nearly midway between the pectoral origin and the base of the caudal; the base is scarcely two ninths of total length without caudal; the posterior and longest rays are scarcely one half as long as the head. The caudal is rounded. D. I, 7; A. 17; V. 10; P. I, 9. In spirits the upper parts are dark brown, the belly and under

surface of head pale. The fins all have a narrow dark margin. The specimen described (no. 18015 U. S. National Museum) is 4½ inches long.

This species, like the others of its genus, is called stone cat, and it is very common in the Susquehanna, where it is highly prized as a live bait for black bass fishing. The species occurs also in the Delaware, but for some reason or other is not so attractive to the black bass as the Susquehanna river race. It grows to the length of 10 inches.

The species ranges from New York to South Carolina, east of the Alleghenies.

The dorsal and caudal fins sometimes have a well defined black margin, from which originated the later name, Noturus marginatus. This is the Pimelodus livrée of Cuvier and Valenciennes and the P. lemniscatus of Le Sueur. Cuvier and Valenciennes make the following concluding remarks about the species: "The species is probably viviparous, for the eggs are very large, and contain a well developed embryo. The ovary contains many eggs of which the diameter exceeds 2 lines, and moreover they are taken from a small animal, for our example is 3 inches long."

54 Schilbeodes miurus (Jordan)

Variegated Stone Cat

Noturus miurus Jordan, Ann. Lyc. Nat. Hist. N. Y. 371, 1877, Bull. 10, U. S. Nat. Mus. 100, figs. 60, 61, 1877; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 99, 1883.

Schilbeodes miurus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 148, 1896, pl. XXIX, fig. 68, 1900.

Body rather stout, subterete, its greatest depth contained from four and one half to five and one half times in total length without caudal; least depth of caudal peduncle three fifths of greatest depth of body. Head one fourth of total length without caudal; eye one fifth the length of head, snout about two sevenths; maxillary barbels reach beyond end of head; mandibulary barbel three fifths as long as the head; lower jaw included. Dorsal origin over middle of pectoral, slightly nearer to anal than to tip of snout, the dorsal base one half as long as

the head; adipose fin with a deep notch but connected with the caudal, its length about equal to head; caudal rounded, its middle rays four fifths as long as the head; anal base as long as the head without the snout; highest ray of dorsal equal to dorsal spine, three fifths as long as head; longest anal ray one half as long as the head, extending to middle of ventral base; ventral fin one half as long as the head; humeral process short.

Body much mottled with black and gray and with four broad dark bands or cross blotches; top of head, tip of dorsal, middle of adipose fin, and edge of caudal blackish; occiput dark. D. I, 6; A. 13 to 15; V. I, 8; P. I, 8.

The variegated stone cat has been assigned to the Mississippi valley, south to Louisiana, to tributaries of Lake Michigan, and to the Ohio valley, where it is common. It appears to have been entirely overlooked by ichthyologists till 1876. Dr Evermann collected five specimens of this fish in Sandy creek at North Hamlin N. Y. Aug. 20, 1894. The probability is that it will be found in other waters of the Great lakes region. The individuals used for illustration are from 3½ inches to 4¼ inches long.

Order PLECTOSPONDYLI

Carplike Fishes

Suborder EVENTOGNATHI

Carps

Family CATOSTOMIDAE

Suckers

Genus CARPIODES Rafinesque

Body oblong; the dorsal outline more or less arched; the ventral outline nearly straight; depth from one half to one third of length; sides compressed, the back sharp edged; caudal peduncle short and deep; head short and deep; its upper surface rounded; eye moderate, median or anterior; suborbital bones well developed; fontanel present; mouth small, horizontal and inferior; mandible short; lips thin, the upper protractile, narrow, the lower narrow; lips feebly plicate or nearly smooth;

jaws without cartilaginous sheath; mucíferous system moderately developed; opercular apparatus well developed, the subopercle broad; isthmus moderate; pharyngeal bones remarkably thin, laterally compressed, with a shallow furrow along the anterior margin on the inside, and another more central on the outline of the enlarged surfaces; teeth very small, compressed, nearly equally thin along the whole inner edge of the bone, forming a fine, comblike crest of minute serratures, their cutting edge rising above the inner margin into a prominent point; gill rakers slender and stiff above, becoming reduced downward; scales large, about equal over the body; lateral line well developed, nearly straight; dorsal fin long, nearly median, somewhat in advance of ventrals, falcate, its anterior rays elevated, often filamentous; caudal fin well forked, the lobes equal; anal fin comparatively long and low, few rayed; ventrals rather short, usually with 10 rays; pectorals short, placed low; air bladder with two chambers. Size medium or rather large. (After Jordan and Evermann)

55 Carpiodes thompsoni Agassiz

Lake Carp; Drum

Catostomus cyprinus Thompson, Hist. Vermont, 133, 1842.

Carpiodes thompsoni Agassiz, Am. Jour. Sci. Arts, 191, 1855; Cope, Proc. Ac. Nat. Sci. Phila. 285, 1864; Jordan, Man. Vert. 297, 1876; Jordan, Bull. 12, U. S. Nat. Mus. 198, 1878; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 119, 1883.

Body short and stout, the back strongly arched, the greatest depth two fifths of the length to base of caudal fin; head short, about one fourth of length, the snout acutely pointed; lips thin, white, meeting at a wide angle; tip of lower jaw much in advance of nostrils; maxillary reaching to below front of orbit; eye small, about one fifth length of head; dorsal about median, its rays considerably produced, the longest two thirds as long as base of fin; scales rather closely imbricated, 8–39 to 41–6. D. 27; A. 7; V. 10.

Abundant in the Great lakes region. Found in Lake Champlain.

Genus CATOSTOMUS Le Sueur

Body elongate, fusiform, rounded, tapering anteriorly and posteriorly; head long, with pointed snout; eye small, placed high; suborbital bones narrow; fontanel present, large; mouth rather large, inferior, upper lip thick, protractile, papillose, lower lip greatly developed, with a broad free margin, usually deeply incised behind, so that it forms two lobes which are often more or less separated; mandible horizontal, short; opercles moderate; pharyngeal bones moderate, their teeth shortish, vertically compressed, rapidly diminishing in size upward; scales comparatively small; typically much smaller and crowded anteriorly; lateral line well developed, straightish; dorsal nearly median, with from 9 to 14 rays; anal fin short and high, with seven developed rays; ventrals inserted under the middle or posterior part of dorsal, with 9 to 10 rays; caudal fin forked, the lobes nearly equal. In males the fins are higher, and the anal is swollen and tuberculate in the spring. Air bladder with two chambers, the posterior large. Vertebrae 45 to 47. (After Jordan and Evermann)

56 Catostomus catostomus (Forster)

Long-nosed Sucker

Cyprinus catostomus FORSTER, Phil. Trans. LXIII, 155, tab. 6, 1773.

Catostomus hudsonius LE SUEUR, Jour. Ac. Nat. Sci. Phila. I, 107, 1817; GÜNTHER, Cat. Fish. Brit. Mus. VII, 13, 1868.

Catostomus longirostris JORDAN, Bull. 12, U. S. Nat. Mus. 175, 1878; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 126, 1883.

Catostomus nanomyzon MATHER, App. 12th Rep't Adirondack Surv. N. Y. 36, plate, fig. 1, 1886.

Catostomus catostomus JORDAN, Cat. Fish. N. A. 17, 1885; BEAN, Fishes Penna. 25, pl. 20, fig. 30, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 176, 1896, pl. XXXII, fig. 77, 1900.

The northern sucker has an elongate body, round and tapering, with a long and rather slender head. The depth of the body is contained about four and one half times in the length and equals length of head. The snout is much longer than in C. t e r e s, considerably overhanging the mouth, which is large, with thick coarsely tuberculated lips. Eye small, two fifths as long as the snout and one sixth as long as head; its position

in the head is exactly median. Dorsal origin equidistant from tip of snout and base of caudal; dorsal base as long as head without snout; longest ray one sixth of total length without caudal, twice as long as the last ray. Distance from ventral origin to anal origin equals length of head. Anal base one half as long as dorsal base; longest anal ray equal to longest of dorsal and twice as long as last ray. Ventral origin is under middle of dorsal; the fin equal to head without snout. Pectoral nearly one fifth of total length without caudal. D. 10 to 11; A. 7 to 8; V. 10. Scales usually about 100 in lateral line and in 28 rows from dorsal origin to ventral origin.

The northern sucker, long-nosed sucker, or red-sided sucker, as the above species is styled, occurs in the Great lakes and northwest to Alaska in clear, cold waters. It is very common in Lake Erie. It grows to a length of 2 feet and is largest and most abundant northward, in Alaska reaching a weight of 5 pounds. As a food fish the long-nosed sucker is little esteemed; but in cold countries the head and roe are used in making a palatable soup.

The males in the breeding season, in spring, are profusely covered with tubercles on the head and fins and have a broad rosy band along the middle of the body. In the Yukon river, Alaska, Dr Dall found the fish filled with spawn in April. The eggs are of moderate size and yellow in color. Nelson has seen this species seined by Eskimo in brackish estuaries of streams flowing into Kotzebue sound. W. J. Fisher has collected specimens on the peninsula of Alaska.

This was not found in Cayuga lake basin by Dr Meek, but it occurs in the Adirondack region, and Dr Meek believes it is a member of the Cayuga lake fauna. Dr Evermann obtained five specimens at Grenadier island, N. Y. June 28, 1894.

The small race found by Fred Mather in the Adirondacks is the ordinary dwarf form characteristic of mountain regions. He discovered four individuals, only 4¼ inches long, but mature and breeding "in a little mountain brook emptying into Big Moose nearly north of the Big Moose club house, by a bark

shanty known as 'Pancake Hall'." The fish were spawning, and he discovered many eggs under the stones. The females were brown with white on belly, the male with red stripe on the side.

57 Catostomus commersonii (Lacépède)

Common Sucker

Cyprinus commersonnii Lacépède, Hist. Nat. Poiss. V, 503, 610, 1803.
Cyprinus teres Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 458, 1815.
Catostomus teres Günther, Cat. Fish. Brit. Mus. VII, 15, 1868; Bean, Fishes Penna. 25, 1893.
Catostomus communis De Kay, N. Y. Fauna, Fishes, 196, pl. 33, fig. 106, 1842.
Catostomus pallidus De Kay, N. Y. Fauna, Fishes, 200, pl. 33, fig. 104, 1842.
Catostomus commersoni Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 1883.
Catostomus commersonii Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 178, 1896, pl. XXXIV, fig. 83, 1900.

The common sucker has a moderately stout body, heavy at the shoulders and tapering to the tail. Its greatest depth is contained four and one half times in its length to tail, slightly more than length of head. Head conical, flattened on top; mouth rather large and the lips strongly papillose; dorsal fin situated in middle of length; ventral opposite dorsal; anal far back; second and third branched rays of dorsal highest, two thirds the length of head; third and fourth rays of anal longest, almost equal to length of head. D. 12; A. 7; V. 9. Scales 64; from dorsal to lateral line 9, and from lateral line to ventral, 9 or 10.

The common sucker is also known as the pale sucker, white sucker, gray sucker, brook sucker, and, among the Canadian French, as the *carpe blanche*. It is the commonest member of its genus in waters east of the Rocky mountains. It is found from Canada to Florida and westward to Montana. Covering such a wide range of territory, the species is naturally variable, and has been described over and over again by many authorities under a great variety of names. The male of this sucker in spring has a faint rosy stripe along the middle of the side. The young are brownish in color and somewhat mottled and have a dark median band or a series of large blotches. The

adults are light olive varying to paler and sometimes darker; sides silvery.

The species reaches a length of 22 inches, and a weight of 5 pounds. It is a very common inhabitant of ponds and streams of the lowlands, and a small race occurs in certain cold mountain streams of the Adirondack region, where it is dwarfed in size and changed in color but does not differ in essential characters. Dr Rothrock also obtained a mountain race of this sucker in Twin lakes, Col., at an elevation of 9500 feet above the sea level.

The common sucker is a very indifferent food fish in the estimation of most people, but, when taken from cold waters and in its best condition, its flesh is very palatable. It takes the hook readily when baited with common earthworms.

Dr Richardson says:

It is a common fish in all parts of the fur countries, abounding in the rivers and even in landlocked marshes and ponds, but preferring shallow grassy lakes with mud bottoms. In the beginning of summer it may be seen in numbers forcing its way up rocky streams, and even breasting strong rapids, to arrive at its proper spawning places in stony rivulets; soon afterwards it returns to the lakes. Its food, judging from the contents of the stomachs of those which I opened, is chiefly soft insects; but in one I found the fragments of a fresh-water shell. In the winter and autumn it is common in nets, and in the spawning season (June) may be readily speared, or even taken by the hand in shallow streams. It is a very soft, watery fish, but devoid of any unpleasant flavor, and is considered to be one of the best in the country for making soup. Like its congeners, it is singularly tenacious of life, and may be frozen and thawed again without being killed.

Dr Meek found this species abundant throughout the entire Cayuga lake basin, where it is known as the common white sucker.

Dr Evermann, in his manuscripts on the fishes of Lake Ontario, taken in 1894, mentions this sucker from the following localities: Stony creek, Black river, Mud creek, Cape Vincent, mouth Salmon river, Chaumont river, creek at Pultneyville, mouth Little Salmon creek, Sandy creek, Long pond, Stony Island, Lakeview

hotel, 7 miles northeast of Oswego, and Marsh creek. In the St Lawrence river basin he and Barton A. Bean obtained the young in Racket river, Norfolk N. Y., July 18 and in the St Lawrence river, 3 miles below Ogdensburg, July 17. In the Lake Champlain basin these two collectors secured young and half grown specimens in the Saranac river, at Plattsburg July 28, 1894.

The writer received specimens from Canandaigua lake in November of 1896 and 1897, and seined the young in Bronx river in August 1897. The small mountain form was secured from Saranac lake in November 1897. It is conspicuous for its small size and its red color. The Canandaigua lake suckers, received in November 1896, throve in captivity till July 1897, when the warm water killed them.

Color brownish, olivaceous above, silvery below; the young are much blotched and marked on sides and back. It is occasionally caught on the hook. Young ones, in captivity, though they always grub about, and though they take food offered them, do not thrive and gradually starve. They remain wild and take alarm easily and often leap out of their tank. This species enters slightly brackish water. *Eugene Smith*[1]

58 Catostomus nigricans Le Sueur

Hog Sucker; Stone Roller

Catostomus nigricans Le Sueur, Jour. Ac. Nat. Sci. Phila. I. 102. 1817; Günther, Cat. Fish. Brit. Mus. VII, 17, 1868; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 130, 1883; Bean, Fishes Penna. 26, pl. 21, fig. 31, 1893; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 181, 1896; De Kay, N. Y. Fauna, Fishes, 202, 1842.

Exoglossum (Hypentelium) macropterum Rafinesque, Jour. Ac. Nat. Sci. Phila. I, 420, pl. 17, fig. 3, 1817.

The stone roller has a peculiar physiognomy. The head is flattened on top, the interorbital space is concave and the frontal bone short, broad and thick. The body is subterete, its depth being contained four and one third times in the length without caudal or equal to length of head. The eye is rather small, being contained three times in length of snout; mouth large, lips well developed and strongly papillose; fins all large;

[1] Linn. Soc. N. Y. Proc. 1897. no. 9, p. 13-14.

the dorsal base equals two thirds of length of head, while the pectoral is considerably longer than the dorsal. Caudal moderately forked; lateral line fully developed, on median line of body; scales moderate, equal. D. 11; A. 7; V. 9. Scales 7-52-7.

Specimen examined, no. 8446, U. S. National Museum, from Cayuga lake, N. Y.

The stone roller has a wide distribution and a remarkable variety of common names. Among them are: hammerhead, stone lugger, stone toter, crawl-a-bottom, hog molly, hog mullet, mud sucker, hog sucker, banded sucker, large-scaled sucker, and black sucker. The name, shoemaker, was formerly applied to this species in Lake Erie, perhaps on account of the resemblance of its color to that of shoemaker's pitch.

Prof. Cope says that this species in Pennsylvania is most abundant in tributaries of the Ohio and in the Susquehanna, while in the Delaware it is uncommon. It ranges from western New York to North Carolina and westward to Kansas. It is the most remarkable looking of all the suckers of New York, and may always easily be distinguished by the shape of its head. The species grows very large, reaching a length of 2 feet. It delights in rapid streams of cold, clear water. Its habit is to rest quietly on the bottom, where its color protects it from observation. It is sometimes found in small schools. The spawning season is in spring, and the young are abundant in small creeks, as well as in the rivers. The food consists of insect larvae and small shells, and it is specially fitted for securing its prey under stones in the rapids.

As a food fish this sucker has little value.

Genus ERIMYZON Jordan

Body oblong, compressed; head moderate; mouth moderate, somewhat inferior, the upper lip well developed, freely protractile, the lower moderate, infolded, inversely V-shaped in outline, plicate, with 12 to 20 folds on each side; lower jaw without cartilaginous sheath, rather stronger than usual, and oblique when the mouth is closed; eye moderate; suborbital bones well

developed, not much narrower than the fleshy part of the cheek below them; opercular bones moderately developed, not rugose; fontanel rather large; gill rakers rather long; pharyngeal bones weak; the teeth quite small, slender, and weak, rapidly diminishing in length upward, each tooth narrowly compressed, with a cusp on the inner margin of the cutting surface; scales rather large, more or less crowded forward; no lateral line; dorsal fin rather short and high, rays usually 11 or 12; pectoral fins moderate; anal fin high and short, more or less emarginate or bilobed in adult males; caudal fin moderately forked or lunate, its lobes subequal. Air bladder with two chambers. (After Jordan and Evermann)

59 Erimyzon sucetta (Lacépède)

Chub Sucker

Cyprinus sucetta Lacépede, Hist. Nat. Poiss. V, 503, 606, 610, 1803.
Catostomus sucetta Le Sueur, Jour. Ac. Nat. Sci. Phila. I, 109, 1817.
Labeo gibbosus De Kay, N. Y. Fauna, Fishes, 194, pl. 32, fig. 101, 1842 (dorsal incorrect).
Catostomus tuberculatus De Kay, N. Y. Fauna, Fishes, 199, pl. 31, fig. 97, 1842.
Labeo esopus De Kay, N. Y. Fauna, Fishes, 195, 1842.
Erimyzon goodei Jordan, Bull. 12, U. S. Nat. Mus. 148, 1878; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 134, 1883; Goode, Fish. and Fish. Ind. U. S. pl. 221, 1884.
Erimyzon sucetta (part) Bean, Fishes Penna. 27, 1893.
Erimyzon sucetta Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 185, 1896.

The body of the chub sucker is oblong, rather deep and compressed. Its depth one third of standard length. The head is rather short, broad above, its length one fourth of total length to caudal. The mouth is rather small and but slightly inferior, protractile. The eye is contained five times in length of head and slightly less than twice in its distance from tip of snout. Dorsal short, rather high, placed in middle of length; ventrals directly underneath; highest dorsal ray (fourth) not quite equal to second anal ray, about two thirds of length of head; caudal slightly forked. No lateral line. D. 12 to 15; A. 7 to 8; V. I, 7. Scales 37 to 40; transverse 13 to 15.

The chub sucker here described is the southern form which was first made known by Lacépède from an individual received

from Charleston S. C. Jordan and Evermann now give the distribution of this form as extending from Virginia to Texas. It appears to reach a little farther northward if the references to De Kay are properly made. His Labeo gibbosus and esopus and the Catostomus tuberculatus seem to indicate the southern chub sucker.

The species reaches the length of 1 foot. It has very little value as food, but the young furnish excellent food for the larger fishes and are very interesting for aquarium purposes.

60 Erimyzon sucetta oblongus (Mitchill)

Chub Sucker; Creek Fish

Cyprinus oblongus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 459, 1815.
Labeo elegans De Kay, N. Y. Fauna, Fishes, 192, pl. 31, fig. 100, 1842.
Labeo oblongus De Kay, N. Y. Fauna, Fishes, 193, pl. 42, fig. 136, 1842.
Moxostoma oblongum Günther, Cat. Fish. Brit. Mus. VII, 21, 1868.
Erimyzon sucetta Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 133, 1883; Goode, Fish. and Fish. Ind. U. S. pl. 220, 1884; Bean, Fishes Penna. 27, 1893 (part).
Erimyzon sucetta oblongus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 186, 1896, pl. XXXVI, fig. 89, 1900.

The northern chub sucker has the body more slender, its greatest depth being less than one third of the total length without the caudal. The nape is less gibbous than in E. sucetta. The caudal peduncle is more slender, its greatest depth being scarcely one third of the greatest depth of the body (two fifths in sucetta). The head is small and short, the eye less than one fifth as long as the head, the dorsal base shorter and the fins containing fewer rays (11 in sucetta oblongus, 14 in sucetta).

This is known as the chub sucker, sweet sucker, rounded sucker, creekfish and mullet. It has a wide range, practically including all the waters of the United States east of the Rocky mountains.

The chub sucker grows to a length of about 1 foot. It is very tenacious of life and is a ready biter, but has little value for food. The young up to the length of several inches have a very distinct black lateral band. They are often found in the shelter of water lilies and other aquatic plants close to brackish waters.

Dr Evermann collected two specimens in Black creek, tributary of Oswego river, at Scriba Corners N. Y. July 17, 1894. Dr Meek found it very common about Cayuga and Montezuma N. Y., but did not observe it near Ithaca. In the market of New York, according to De Kay, the chub sucker makes its appearance in October, November and December. Specimens were seined in Bronx river in August 1897.

A young example sent from near Princeton N. J. by Prof. Ulric Dahlgren in September 1897 showed the following voluntary change of color. When it arrived, it had the broad, longitudinal, median band well developed and the vertical bands obsolete; but soon after it was placed in a tank it obscured the longitudinal band entirely and developed the vertical bands.

The food of the chub sucker consists chiefly of minute crustaceans, insect larvae and aquatic plants.

Genus MINYTREMA, Jordan

Body rather elongate, subterete, becoming deep and rather compressed with age; scales rather large and nearly uniform in size; lateral line interrupted in the adult, but with perfect tubes, imperfect in partly grown individuals, and obsolete in the young; head moderate, rather broad above; mouth moderate, inferior, horizontal; the upper lip well developed, freely protractile; the lower rather small, infolded, inversely V-shaped in outline, lower jaw without cartilaginous sheath; eye moderate, rather high, nearly median; suborbital bones well developed; opercular bones well developed, not very rough; fontanel rather large; gill rakers rather long; isthmus moderate; pharyngeal bones essentially as in Moxostoma; dorsal fin rather short and high, inserted somewhat nearer to tip of snout than to base of caudal; pectoral fins moderate, placed low; anal high and short; ventrals short, midway between tip of snout and base of caudal; caudal fin moderately forked, the lobes equal; air bladder with two chambers. Head in males tuberculate in spring.

61 Minytrema melanops (Rafinesque)

Striped Sucker; Spotted Sucker; Sand Sucker

Catostomus melanops RAFINESQUE, Ichth. Ohien. 57, 1820; KIRTLAND, Bost Jour. Nat. Hist. V, 271, pl. 20, fig. 3, 1845.
Catostomus fasciatus GÜNTHER, Cat. Fish. Brit. Mus. VII, 19, 1868.
Minytrema melanops JORDAN, Bull. 12, U. S. Nat. Mus. 138, 1878; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 136, 1883; BEAN, Fishes Penna. 28, pl. 21, fig. 32, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 187, 1896, pl. XXXVI, fig. 90, 1900.

Body oblong, robust in adults, its greatest depth one fourth total length to base of caudal; head moderate, subconical, its length contained about four and one half times in total length; eye placed high and in the middle of length of head, its diameter 2 in snout, 5 in head; nostrils about over the angle of the mouth; scales large, firm, in about 48 longitudinal and 12 or 13 transverse rows; dorsal origin over tip of pectoral, its base as long as its longest ray; ventrals nearly under middle of dorsal, length one sixth of total; longest anal ray nearly one fifth of total; least depth of caudal peduncle about one half the length of head. D. 12; A. 7; V. 9. Color dusky above, coppery below, usually a dusky blotch behind dorsal fin; scales mostly with a dark spot at the base, the spots forming longitudinal stripes.

The striped sucker, also called soft sucker, sand sucker and black-nosed sucker, is found in the Great lakes and south to South Carolina and Texas. In Pennsylvania it is limited to Lake Erie and the Ohio valley. In New York it is to be expected in Lake Ontario and its tributaries, and should also occur in Chautauqua lake.

The striped sucker grows to a length of 18 inches. Old males have the head tuberculate in the breeding season in the spring. The species is very readily distinguished by the dark stripes along the sides produced by spots at the base of each scale. In the young of this sucker there is no lateral line, but in adults it is almost entire.

This sucker prefers clear, sluggish waters and grassy ponds. It readily adapts itself to life in the aquarium. It feeds almost entirely on mollusks, insects and insect larvae. The species is

not much esteemed as a food fish, though it is sold in large numbers.

Minytrema melanops is normally without a lateral line, but this feature is occasionally partially developed and has caused some confusion in assigning certain individuals to their proper genus; indeed, one author has described and figured the striped sucker as two species, belonging to two different genera, having been misled by this undeveloped character.

Genus MOXOSTOMA Rafinesque

Body moderately elongate, sometimes nearly round, usually compressed; scales large, nearly uniform in size; lateral line complete, straight or anteriorly curved; head varying in length, subconical; eye usually rather large, placed moderately high; suborbital bones very narrow; fontanelle well developed; mouth varying much in size, inferior, the mandible horizontal or nearly so; lips unusually well developed, the form of the lower varying, usually with a slight median fissure, but never deeply incised; lips with transverse folds which are rarely broken up to form papillae; jaws without cartilaginous sheath; muciferous system well developed; opercular bones moderately developed, nearly smooth; isthmus broad; gill rakers weak, moderately long; pharyngeal bones rather weak, the teeth rather coarser than in Erimyzon and Catostomus, strongly compressed, the lower five or six stronger than the others, which rapidly diminish in size upward, each with a prominent internal cusp; dorsal fin nearly median, moderately long; anal fin short and high, with seven developed rays; caudal fin deeply forked; air bladder with three chambers. (After Jordan and Evermann)

62 Moxostoma anisurum (Rafinesque)

White-nosed Sucker

Catostomus anisurus Rafinesque, Ichth. Ohien. 54, 1820; Kirtland, Bost. Jour. Nat. Hist. V, 269, pl. 20, fig. 2, 1845; Storer, Syn. Fish. N. A. 172, 1846.

Catostomus carpio Günther, Cat. Fish. Brit. Mus. VII, 20, 1868.

Myxostoma anisura Jordan, Man. Vert. ed. 2, 315, 1878; Bull. 12. U. S. Nat. Mus. 126, 1878.

Moxostoma anisurum JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 141, 1883; BEAN, Fishes Penna. 28, 1893; JORDAN & EVERMANN, Bull. 47 U. S. Nat. Mus. 190, 1896.

The body is elongate, little compressed, slightly arched anteriorly, its greatest depth contained three and one third times in the length to end of scales. The head is moderate, flat and broad above, its length less than one fourth of the total without the caudal. Mouth slightly inferior; upper lip thin, lower strongly V-shaped; eye large, about one half as long as the snout, which is rather blunt and does not project much beyond the mouth; fins all well developed. The dorsal is large; its first ray is as long as the base of the fin, or about seven eighths as long as the head. Upper margin of dorsal nearly straight. Pectorals nearly reach to ventrals; the upper caudal lobe narrow and longer than the lower. D. 15; A. 7 to 8; V. 8. Scales 5 to 6–43 to 46 4 to 5. Here described in part from a specimen measuring 16 inches, from Ohio.

The white-nosed sucker is found sparingly in the Ohio river and the Great lakes region; widely distributed, but nowhere abundant. Cuvier and Valenciennes received from Milbert a specimen sent from Lake Ontario, measuring about 2 feet. Dr Jordan says this is very closely related to the common red horse, from which it can hardly be distinguished except by its fins. Dr Evermann collected a single specimen at Fox island, N. Y. June 29, 1894; he also obtained a specimen, 12 inches long, at Pointbreeze N. Y. Aug. 21, 1894, which he refers to this species, though indicating some characters in which it differs from the normal form of the white-nosed sucker.

63 **Moxostoma aureolum** (Le Sueur)

Red Horse

Catostomus aureolus LE SUEUR, Jour. Ac. Nat. Sci. Phila. I, 95, 1817; DE KAY, N. Y. Fauna, Fishes, 201, pl. 42, fig. 133, 1842.

Catostomus oneida DE KAY, N. Y. Fauna, Fishes, 198, 1842. Oneida Lake.

Catostomus duquesnii KIRTLAND, Bost. Jour. Nat. Hist. V, 268, pl. 20, fig. 1, pl. 21, fig. 2, 1845; GÜNTHER, Cat. Fish. Brit. Mus. VII, 18, 1868, Youghiogheny River, Pa.

Moxostoma aureolum JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 140, 1883; BEAN, Fishes Penna. 30, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 192, 1896.

Body oblong, the back in front of dorsal elevated and compressed, head short, conical, broad between eyes. The eye is rather large, one fourth length of head, which is contained five times in total length without caudal. The depth of the body is contained three and one half times in this length. Caudal peduncle deep, compressed, its least depth equal to one half the length of head; mouth small; the snout somewhat projecting; fins all well developed; the anterior rays of dorsal longest, as long as dorsal base, pectoral or longest anal rays, equaling length of head; caudal forked; scales large, about equal in size all over the body, and finely striated. D. 15; A. 8. Scales 6–46 –6; lateral line complete.

The red horse has the additional names of golden red horse, golden sucker, mullet, golden mullet, and lake mullet. It inhabits the Great lakes and the region northward, also the Ohio valley. It is common in Lake Erie but not in the Ohio.

This species grows to a length of 18 inches and is one of the handsomest of the suckers. Prof. Forbes records it from lakes of northern Illinois, also abundantly in the central part of that state.

Dr Evermann, in collecting fishes of the Lake Ontario region, secured it at the following localities: Lake Ontario, 4 miles off Nine Mile point, N. Y. June 12, 1893; lake shore, 3 miles west of Oswego, July 17, 1894; mouth Salmon river, July 25, 1894; Long pond, Charlotte N. Y. Aug. 17, 1894; Sandy creek, North Hamlin N. Y. Aug. 20, 1894.

Dr Meek identified a single specimen of the so called common red horse of Cayuga lake with Moxostoma macrolepidotum, and stated, on the authority of Mr Kipp, that it is common at the northern end. Jordan and Evermann, however, do not extend the range of macrolepidotum so far north, and it is probable that the common Moxostoma of Cayuga lake is M. aureolum.

De Kay records the species as very common in Lake Erie. In August and September he observed them to be full of worms. In his *New York Fauna, Fishes*, p. 198, he describes a sucker or mullet under the name Oneida sucker. This, he stated, is com-

mon in Oneida lake. The species is considered identical with Moxostoma aureolum. His description shows a very close agreement with that of aureolum given above.

The food of the red horse consists chiefly of mollusks and insects. It is not a choice food fish.

Eugene Smith[1] records this form as occurring in the vicinity of New York city. Mention has already been made of the doubt concerning the northern limits of the range of macrolepidotum; but for the sake of comparison the brief description of macrolepidotum published by Jordan and Evermann is given herewith.

Head moderate, rather stout, its length four and three fifths in body; eye one and two thirds in snout; dorsal fin with its free edge concave; scales usually with dusky shade at base; lower fins pale. Streams about Chesapeake and Delaware bays, and southward to North Carolina. It seems in some respects intermediate between M. aureolum and M. crassilabre, but we can not at present identify it with either.

Family CYPRINIDAE

Carps

Genus CAMPOSTOMA Agassiz

Body moderately elongate, little compressed; mouth normal, the jaws with thick lips and rudiment of a hard sheath; premaxillaries protractile; no barbel; teeth 4–4, or 1, 4–4, 0, with oblique grinding surface, and a slight hook on one or two teeth; air bladder suspended in the abdominal cavity and entirely surrounded by many convolutions of the long alimentary canal, which is six to nine times the total length of the body; ovaries similarly enclosed by the alimentary canal; peritoneum black; pseudobranchiae present; scales moderate; lateral line present; dorsal nearly over ventrals; anal short; no spines. Herbivorous. Sexual differences very great, the males being covered with large tubercles in spring. The singular arrangement of the intestines in relation to the air bladder is peculiar to Campostoma among all known fishes. (After Jordan and Evermann)

[1]Linn. Soc. N. Y. Proc. 1897. no. 9, p. 14.

64 Campostoma anomalum (Rafinesque)

Stone Roller; Stone Lugger

Rutilus anomalus Rafinesque, Ichth. Ohien. 52, 1820.
Exoglossum dubium Kirtland, Bost. Jour. Nat. Hist. V, 272, pl. 21, fig. 1, 1845.
Campostoma dubium Günther, Cat. Fish. Brit. Mus. VII, 183, 1868.
Compostoma anomalum Agassiz, Amer. Jour. Sci. Arts, 218, 1855; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 149, 1883; Bean, Fishes Penna. 32, 1893; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 205, 1896, pl. XXXIX, fig. 95, 1900.

In the stone roller the body is moderately stout and not greatly compressed; the caudal peduncle long and deep. The greatest depth of the body is contained four to four and one half times in the total length without the caudal; the depth of the caudal peduncle, eight and one half to nine times in the same length. The snout is obtuse, twice as long as the eye, and two fifths as long as the head. The maxilla reaches to the vertical from the posterior nostril, which is more than twice as far from tip of snout as from eye. The dorsal origin is over the 20th scale of the lateral line, and the ventral origin under the 19th. The dorsal base is one half and its longest ray two thirds as long as the head. The ventral reaches nearly to vent. The pectoral is one sixth of total length without caudal. The anal origin is under the 32d scale of the lateral line; the anal base is as long as the snout, and the longest ray equal to head not including the snout. The caudal is moderately forked. D. 8; A. 7 or 8. Scales 8–52 to 53–8; teeth 4–4.

Color in spirits brownish above, lower parts pale. In living examples the scales are somewhat mottled with blackish, and there is a dusky vertical bar behind the opercle; dorsal and anal fins olivaceous in females and with a nearly median dusky cross bar. Breeding males have the iris orange, the dorsal and anal fins crimson, and the head and sometimes the body covered with large roundish tubercles.

The stone roller is likewise called stone toter, stone lugger, and steel-back minnow. It is a fish of very wide distribution, ranging from western New York to North Carolina and throughout the Ohio and Mississippi valleys, west to Wyoming

and southwest to Texas. It is an extremely variable species and everywhere common. The species grows to the length of eight inches. It has no importance as food for man. It feeds on aquatic plants. The young are hardy in the aquarium, where they feed on confervae and diatoms. The sexes are very unlike. The males in the breeding season have the head and frequently the entire body covered with large tubercles and the upper half of the dorsal and anal fins fiery orange, with a dark cross bar about the middle of these fins.

The fish is rather sluggish, but when frightened its movements are very rapid. It is a bottom feeder.

Dr Evermann collected a moderate number of specimens at the following New York localities: Salt brook, 1½ miles above Nine Mile point, June 11, 1893; creek, Pultneyville, Aug. 7, 1894; Long pond, Charlotte, Aug. 17, 1894; Marsh creek, Point Breeze, Aug. 21, 1894.

Genus CHROSOMUS Rafinesque

Body moderately elongate, little compressed; jaws normal; no barbel; teeth 5–5 or 4–5, moderately hooked, with well marked grinding surface; alimentary canal elongate, about twice as long as body; peritoneum black; scales very small; lateral line short or wanting; dorsal behind ventrals; anal basis short. Size small. Colors in spring brilliant, the pigment bright red. This genus is of somewhat doubtful relationship, and shows many analogies with the subgenus Phoxinus under Leuciscus. (After Jordan and Evermann)

65 Chrosomus erythrogaster Rafinesque

Red-bellied Dace

Luxilus erythrogaster RAFINESQUE, Ichth. Ohien. 47, 1820; KIRTLAND, Bost. Jour. Nat. Hist. IV, pl. II, fig. 2, male and female, 1844.

Leuciscus erythrogaster GÜNTHER, Cat. Fish. Brit. Mus. VII, 247, 1868.

Chrosomus erythrogaster COPE, Trans. Am. Phil. Soc. XIII, 391; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 153, 1883; BEAN, Fishes Penna. 32, pl. 22, fig. 35, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 209, 1896.

The red-bellied dace has a fusiform, moderately elongate and thick body, whose greatest hight is contained from four and

one fifth to five times, and the least depth of its caudal peduncle eight and one half times, in the total length to the caudal base. The head is conical with pointed snout as long as the eye, which is about one fourth as long as the head. The head equals one fourth of total length to caudal base. The maxilla reaches nearly to below the front of the eye. The lateral line varies in development, sometimes reaching to above the origin of the ventrals and continued backward even farther at intervals, but usually not extending to ventrals. The dorsal origin is over the space between the ventral origin and the vent; about 39 rows of scales between it and the nape. The dorsal base is one half as long as the head; the longest ray equals head without snout. The pectoral reaches nearly to ventral origin, and the ventral reaches vent. The anal base is two fifths as long as the head; the longest ray equal to longest of the dorsal. The caudal is moderately forked, its middle rays two thirds as long as the outer. D. 8; A. 7; V. 8; P. 12. Scales 18–80 to 85-10; teeth 5–5. Length of specimens described, from Yellow creek, 3 inches. A narrow dusky line along the top of the back; two narrow, dark bands on the sides, the lower one passing forward on the head to tip of snout; the space between the bands and below bright silvery. Breeding males have the bases of the dorsal, anal and caudal fins and the area between the dark bands scarlet, while the body is covered with minute tubercles, and the fins generally are vivid yellow.

The U. S. Fish Commission parties obtained this minnow at the following localities in the Lake Ontario region: Salt brook, 1½ miles above Nine Mile point, June 11, 1893; Cemetery creek, or Black river, Watertown, July 5, 1894; Long pond, Charlotte, Aug. 17, 1894. I am unable to find a reference to this species in the works of Mitchill and De Kay.

The red-bellied minnow or dace is found from Pennsylvania to Dakota and Tennessee. It is abundant in small streams, and is a strikingly beautiful fish. Along the sides are two blackish bands; one beginning above the eye and extending to the tail; another traverses the eye and follows the lateral line

to the base of the caudal, where it ends in a black spot. The belly and the space between the bands are bright silvery, replaced by scarlet red in breeding males, which have the same color at the bases of the dorsal, caudal and anal fins. In the hight of the breeding season the fins are bright yellow, and the body is covered with small tubercles. According to Prof. Cope the red-bellied minnow is not found in the Delaware, but it occurs in the Susquehanna and is common in the streams of western Pennsylvania. It reaches a length of 3 inches, and is similar in its habits to the stone roller, with which it associates. It prefers clear streams, which have their origin in springs. As an aquarium fish this is scarcely excelled in beauty and hardiness, and as a bait for the black bass it has few superiors.

Genus HYBOGNATHUS Agassiz

Body elongate, somewhat compressed; mouth horizontal, the jaws normal, sharp edged; lower jaw with a slight, hard protuberance in front; no barbel; upper jaw protractile; teeth 4–4, cultriform, with oblique grinding surface and little if any hook; alimentary canal elongate, three to 10 times the length of the body; peritoneum black; scales large; lateral line continuous; dorsal inserted before ventrals; anal basis short. Size moderate. Sexual changes very slight, no red or black pigment distinguishing the males in spring. Species numerous, mostly southwestern, not well known.

66 Hybognathus nuchalis Agassiz

Silvery Minnow

Hybognathus nuchalis AGASSIZ, Am. Jour. Sci. Arts, 224, 1855; GÜNTHER, Cat. Fish. Brit. Mus. VII, 184, 1868; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 156, 1893; BEAN, Fishes Penna. 33, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 213, 1896.

Hybognathus regius GIRARD, Proc. Ac. Nat. Sci. Phila. 209, 1856; GÜNTHER, Cat. Fish. Brit. Mus. VII, 185, 1868.

Hybognathus osmerinus COPE, Proc. Am. Phil. Soc. Phila. 466, 1870 (Raritan river, N. J.).

Body moderately stout and short, its greatest depth equaling one fourth of the total length without the caudal, and the least

depth of the caudal peduncle equaling nearly one half of the greatest depth of the body; body compressed, its greatest width less than one half its hight. Head short, its upper and lower profiles tapering equally into the short and not very obtuse snout, which is as long as the eye, and three elevenths as long as the head. Mouth small, slightly oblique, the jaws nearly equal, or the lower slightly included, the maxilla without a barbel, and reaching to below the anterior nostril. The dorsal origin is over, and the ventral origin under, the 12th scale of the lateral line. The dorsal base is two thirds as long as the head; the longest dorsal ray equals the distance from the nostril to the end of the operculum, and the last ray is less than one half as long as the longest. The ventral does not reach to the vent; its length two thirds that of the head. The anal origin is under the 24th scale of the lateral line; the anal base is scarcely as long as the postorbital part of the head; the last anal ray is one third, and the longest anal ray two thirds, as long as the head. The pectoral is four fifths as long as the head, and reaches to below the 11th scale of the lateral line. The caudal is moderate in size and deeply forked, the middle rays less than one half as long as the external rays. D. ii, 7; A. ii, 7; V. 8; P. 15. Scales 6—38 to 39--4; teeth 4--4 long, much compressed, and with a long oblique grinding surface. Intestines seven to 10 times as long as the body. The lateral line is gently decurved on about the first six scales, thence straight and median to the root of the caudal fin. Color in spirits light brown with a broad silvery band, the fins all pale. Olivaceous green above, translucent in life; sides silvery, with bright reflections; fins unspotted. Length 4 to 7 inches.

The silvery minnow, or blunt jaw, is found in clear streams from New York to Georgia and Texas, west to the upper Missouri. In the Potomac river occurs a large variety which reaches a length of 7 inches. This variety has a larger eye and a deeper body than the western form.

The U. S. Fish Commission collectors in the Lake Ontario region obtained specimens at the following localities: Salt

brook, 1½ miles above Nine Mile point, June 11, 1893; Mill creek, Sacketts Harbor, July 2, 1894; Cemetery creek Watertown, July 5, 1894. The fish was most abundant at Mill creek.

The fish spawns in the early spring. It is extensively used for food along with the Notropis hudsonius, the so called "smelt" or "gudgeon." It takes the hook very freely during the spawning season.

Genus PIMEPHALES Rafinesque

Body rather robust, little compressed; head short and rounded, mouth small, inferior; upper jaw protractile; no barbel; teeth 4 4, with oblique grinding surface, usually only one of the teeth hooked; dorsal over ventrals, its first (rudimentary) ray separated from the rest by membrane, not joined to them as usual in minnows, this character most distinct in adult males, in which the skin of the first ray is thickened; anal basis short; intestinal canal elongate; peritoneum black; pseudobranchiae present; scales rather small; lateral line complete or variously incomplete. Size small. Breeding males with much black pigment and with large warts on the head. (After Jordan and Evermann)

67 Pimephales promelas Rafinesque

Fathead; Blackhead Minnow

Pimephales promelas RAFINESQUE, Ichth. Ohien. 53, 1820; KIRTLAND, Bost. Jour. Nat. Hist. III, 475, pl. 27, fig. 2, 1841; STORER, Syn. Fish. N. A. 166, 1846; GÜNTHER, Cat. Fish. Brit. Mus. VII, 181, 1868; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 158, 1883; BEAN, Fishes Penna. 35, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 217, 1896.

The fathead minnow has a short, deep and moderately thick body, and the head short with a very obtuse snout. The greatest depth of the body is equal to or slightly greater than length of head and is contained from three and two thirds to four and one fourth times in total length without caudal. The least depth of the caudal peduncle equals the length of postorbital part of the head. The head forms about one fourth of the total length to base of caudal; the width of the head equals two thirds of its length. The eye is as long as the snout and two ninths as long

as the head. The mouth is very small, terminal, slightly oblique; the maxilla not reaching vertical through hinder nostril. The dorsal origin is above, and the ventral origin below the 21st scale of the lateral line. The dorsal base is two thirds as long as the head; the first ray is about as long as the eye, and the longest as long as the head without the snout. The ventral reaches a little beyond the anal origin; its length equal to dorsal base. The anal base equals nearly one half the length of head, and the longest ray is as long as the dorsal base. The caudal is moderate and not deeply forked. The lateral line is continuous on about 20 to 28 scales, and in one specimen continued with interruptions almost to the caudal base. D. i, 8; A. i, 7; V. 8; P. 18. Scales 9–45 to 49 6; teeth 4–4. Length of specimens described, 3 inches. Color in spirits light brown, top and sides of head darker. A broad dark band on the base of the dorsal, most distinct anteriorly and sometimes absent behind. Males in spring are dusky, with black head and the snout and chin with numerous coarse tubercles.

The fathead or blackhead is an inhabitant of the Ohio valley, and the Great lakes region west to Dakota and southwest to Texas. It is common in sluggish brooks, and instances have been known of its distribution by the action of cyclones. In Pennsylvania it is common in tributaries of the Ohio.

The U. S. Fish Commission has obtained specimens from the following localities in the basin of Lake Ontario: Salt brook, 1½ miles above Nine Mile point, June 11, 1893; Mill creek, Sackett Harbor, July 2, 1894; Three Mile creek, Oswego, July 27, 1894, where the greatest number of individuals was taken. Dr Meek says it is not very common in Cayuga lake, but is easily distinguished from the other minnows by its very long intestines.

The fathead grows to a length of 2½ inches. The sexes differ in color, the females being olivaceous, while the males are dusky and in the spring have the head black and the snout covered with numerous large tubercles. The species has no value as food, but is an interesting one for the aquarium. Its food consists of mud and algae, and it seems to prefer a muddy bottom.

68 Pimephales notatus (Rafinesque)

Blunt-nosed Minnow; Spotted Minnow

Minnilus notatus RAFINESQUE, Ichth. Ohien. 47, 1820.

Hyborhynchus notatus COPE, Trans. Am. Phil. Soc. XIII, 392, pl. 13, fig. 5, 1866 (the separate); GÜNTHER, Cat. Fish. Brit. Mus. VII, 182, 1868; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 159, 1883.

Pimephales notatus JORDAN, Cat. Fish. N. A. 22, 1885; BEAN, Fishes Penna. 36, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 218, 1896.

The blunt-nosed minnow has a moderately elongate body and a slender caudal peduncle. The head is somewhat conical with a short and blunt snout. The greatest depth of the body nearly equals length of head and is two ninths of the total length without caudal. The least depth of the caudal peduncle equals about one half of greatest depth of body. The snout is as long as the eye and one fourth as long as the head. The mouth is very small, inferior, nearly horizontal, the maxilla reaching to below the anterior nostril and provided with a short, thick, somewhat club-shaped barbel. The dorsal origin is slightly behind the ventral origin and over the 17th scale of the lateral line. The dorsal base is two thirds as long as the head, and about equal to the longest ray. The ventral origin is under the 16th scale of the lateral line; the fin does not reach to the vent. The anal origin is under the 27th scale of the lateral line; the base of the anal is two fifths as long as the head, and the longest ray is equal to the postorbital part of the head. The caudal is moderately large and forked. The lateral line curves very slightly downward as far as the ventral origin and then follows straight along the median line; it is complete. D. i, 8; A. i, 7; V. 8; P. 15. Scales 6–42 to 45–5; teeth 4–4. Length of specimens described, 3 inches. Color in spirits light brown; the fins except the dorsal paler. A black spot about as large as the eye on the front of the dorsal. In life the sides are bluish. Breeding males have the black on the dorsal continued backward on the membrane covering the rays and the head black, while the snout has about 14 to 17 large, pointed tubercles. A dusky shade sometimes present at base of caudal.

The blunt-nosed minnow is a larger species than the fathead, reaching a length of 4 inches, and its range extends from Quebec to Delaware, west to Kansas and south to Mississippi.

B. W. Evermann and B. A. Bean obtained it for the U. S. Fish Commission in the St Lawrence river, 3 miles below Ogdensburg, July 17, 1894, in abundance. They found it common also at Scioto creek, Coopersville N. Y. July 19, 1894. In the Lake Ontario region the Fish Commission collected the species at Cape Vincent, Grenadier island, Sacketts Harbor, Pointbreeze, Huntingtonville, Charlotte, Stony Island, Pultneyville, Chaumont, Henderson bay, and Salt brook. Livingston Stone obtained the fish at Cape Vincent in the St Lawrence river, and presented it to the state museum at Albany. It is found in large numbers in the southern end of Cayuga lake, and in streams on the flats. Not very abundant at the northern end of the lake and in streams near Ithaca, above the falls, according to the records of Dr Seth E. Meek.

The blunt-nosed minnow differs from the fathead in its larger size and in having a complete lateral line, but the sexual differences are similar in the two species. The males in spring have the head black and the snout with many large tubercles. The species is extremely variable and changes greatly with age. It frequents small and muddy streams, and its food consists of decaying vegetable matter.

Genus SEMOTILUS Rafinesque

Body stout, moderately compressed and elongate; mouth terminal, wide, the upper jaw protractile; a small barbel just above the end of the maxillary; in most American minnows the barbel is at its tip; the maxillary barbel sometimes absent in young individuals; teeth 2, 5–4, 2, hooked, without grinding surface; scales rather large; lateral line complete; a short intestinal canal; dorsal placed behind ventrals; base of anal short. Vertebrae $22 + 20 = 42$. Fishes of large size in clear, swift streams from Canada to Virginia, west to Missouri and Wyoming.

69 Semotilus bullaris (Rafinesque)

Fallfish; Wind Fish; Dace; Chivin; Silver Chub

Cyprinus bullaris RAFINESQUE, Amer. Month. Mag. II, 120, Dec. 1817.

Cyprinus corporalis MITCHILL, Amer. Month. Mag. II, 324, Mar. 1818. Previous notice in same work, vol. I, 289, July, 1817, insufficient to hold name. The Corporaalen of the Dutch, moreover, was the striped species, *atromaculatus*.

Semotilus bullaris JORDAN, Man. Vert. ed. 1, 1876; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 222, 1883; BEAN, Fishes Penna. 50, pl. 24, fig. 41, 1893; GOODE, Fish. & Fish. Ind. U. S. pl. 228, upper figure, 1884.

Leuciscus nitidus DEKAY, N. Y. Fauna, Fishes, 209, pl. 33, fig. 105, 1842. Lake Champlain.

Leuciscus chrysopterus DE KAY, N. Y. Fauna, Fishes, 211, pl. 30, fig. 95 (poor), 1842, harbor of New York.

Semotilus corporalis JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 221, 1896.

The fallfish has a moderately deep, elongate and compressed body and a stout caudal peduncle. The greatest depth is one fourth of the total length without caudal, and the least depth of the peduncle equals three eighths of length of head. The head is rather large, one fourth of total without caudal, with pointed snout, which is two sevenths of the head's length. The mouth is oblique; the jaws nearly equal, the maxilla extending to below front of eye. The eye is placed high and is about one fourth as long as the head. The dorsal origin is over the 16th or 17th scale of the lateral line; the base of the fin is one half, and the longest ray two thirds as long as the head. The ventral origin is under the 15th scale of the lateral line; the fin does not reach to the vent, its length one seventh of total without caudal. The anal origin is under the 27th scale of the lateral line; the base of the fin is one third as long as the head, and the longest ray is as long as the ventral. The caudal is large and deeply forked. The lateral line curves downward abruptly over the pectoral, becoming median over the end of that fin. D. ii, 7; A. ii, 7; V. 8; P. 18. Scales 7—46—5; teeth 2, 5—4, 2 or 2, 4—4, 2, all more or less strongly hooked. In spirits the upper parts are grayish brown, the sides and cheeks silvery, the lower parts whitish, the fins all pale. In life the upper parts are steel blue, the sides and belly silvery; breeding males in spring have the

belly and lower fins rosy. The specimens described, no. 9202, U. S. National Museum, are from 5½ to 6¼ inches long.

The fallfish or dace is one of the largest of the minnow family in New York, reaching a length of 18 inches, and it is one of the most beautiful species as well as game in its qualities. As a food fish, however, this is not greatly esteemed. It is extremely common in the Delaware river and its tributaries and moderately abundant in the Susquehanna. The fallfish is found from Quebec to Virginia. Mitchill had it from the Wallkill river and knew of its occurrence in the Hudson, near Albany. Rafinesque recorded it from the Fishkill and other tributaries of the Hudson. De Kay knew it from Lake Champlain and from New York harbor. Evermann and Bean collected it in Scioto creek, at Coopersville, and in Saranac river, at Plattsburg, in July 1894; also in Racquette river, at Norfolk, and the St Lawrence river, 3 miles below Ogdensburg, in the same month.

In the Lake Ontario basin the U. S. Fish Commission parties found it at Sacket Harbor, Centerville, Watertown, Oswego, Webster, Charlotte, Belleville, Henderson bay, Henderson Harbor, and Salt brook, near Nine Mile point.

The fallfish delights in rapid, rocky portions of large streams and in the deep channels. On being hooked, it fights desperately for a short time, but its resistance is soon overcome. Thoreau describes it as a soft fish with a taste like brown paper salted, yet the boy fishermen will continue to covet and admire this handsome and ubiquitous representative of the minnow family. A colored plate of the fish, natural size, appears in the *3d Annual Report of the Commissioners of Fisheries, Game and Forest of the State of New York*, 1898, facing p. 146. There is also a good account of the fish by A. N. Cheney on p. 244 and 245 of the same report.

70 Semotilus atromaculatus (Mitchill)

Horned Dace; Chub

Cyprinus atromaculatus Mitchill, Amer. Month. Mag. II, 324, Mar. 1818. Wallkill river.

Leuciscus atromaculatus De Kay, N. Y. Fauna, Fishes, 210, pl. 32, fig. 102, 1842.

Semotilus corporalis COPE, Jour. Am. Phil. Soc. XIII, 362, pl. 10, fig. 2. (the separate), 1866; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 221. 1883; GOODE, Fish. & Fish. Ind. U. S. pl. 228, lower figure, 1884.
Leucosomus corporalis GUNTHER, Cat. Fish. Brit. Mus. VII, 269, 1868.
Semotilus atromaculatus BICKNELL & DRESSLAR, Proc. Ac. Nat. Sci. Phila. 16, 1885; BEAN, Fishes Penna. 51, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 222, 1896; pl. XL, fig. 100, 1900.

The chub has a slender and moderately elongate body, its greatest hight immediately in front of the ventrals, about equal to the length of the head without the snout and contained from four to nearly five times in the total length without the caudal. The greatest thickness of the body is about two thirds of its greatest hight. The head is thicker than the body and rather short with an obtuse and moderately declivous snout, whose length is about two sevenths of that of the head and considerably greater than the diameter of the eye. The eye is rather small, placed high, its diameter nearly one fifth of the length of the head and scarcely more than one half of the space between the eyes. The mouth is moderate, very slightly oblique, the jaws subequal or the lower slightly included; the end of the maxilla reaches very slightly past the vertical through the front of the eye. Maxillary barbel not evident in this example, though usually present in large individuals. The lateral line is abruptly bent downward over the first half of the pectoral, straight and nearly median during the rest of its course. The origin of the dorsal is over the 27th scale of the lateral line, and the ventral origin is under the 24th scale. The length of the dorsal base equals the combined length of the eye and snout. The first divided ray is the longest; its length two thirds that of the head. The last ray is one half as long as the longest. The ventral does not reach to the vent; its length scarcely greater than the postorbital part of the head. The anal origin is under the 37th scale of the lateral line; the length of the anal base is a little more than one third that of the head, and the longest anal ray equals the postorbital part of the head. The tail is rather slender, the least depth of the caudal peduncle equaling one half the greatest depth and the distance of the anal from the origin of the middle caudal rays nearly equal to

the length of the head. The pectoral when extended reaches to below the 16th scale of the lateral line. The caudal is moderate in size and not very deeply forked, its middle rays being about two thirds as long as the external rays. D. ii, 7; A. iii, 8; V. 8; P. 15. Scales 9 –58—6. Teeth of right side 2 + 5; of left side 2 + 4. Those of the left side strongly and those of the right side less strongly hooked. Teeth of the upper row with a well developed grinding surface.

The length of the specimen described, no. 21661, U. S. National Museum, from the Susquehanna river at Bainbridge Pa., is 4¼ inches.

The color is bluish brown above; sides with a distinct dusky band, not so wide as the eye and becoming obsolete in the adult. Young specimens have the end of this band more pronounced, forming a black spot at the base of the caudal. A small black spot always present on the front of the base of the dorsal, its size in the specimen described being about two thirds of that of the eye. In life the belly is whitish. Breeding males have the belly rose tinted and the black dorsal spot bordered with red; they have, also, rather large tubercles on the snout.

The common chub, creek chub, smaller fallfish or horned dace has a wider distribution than S. bullaris, but it does not grow quite so large, seldom exceeding 1 foot in length. Its range extends from New England to Missouri, southward to Georgia and Alabama. It is extremely common and ascends the small streams.

The U. S. Fish Commission collectors in 1894 took numerous specimens at the following localities: Sacketts Harbor, July 2; Centerville, July 24; Watertown, July 5; Oswego, July 25; Webster, Aug. 9; Charlotte, Aug. 17; Belleville, July 12; Henderson bay, July 4; Henderson Harbor, July 3, and Salt brook, 1½ miles above Nine Mile point, June 10 and 11, 1893.

Dr Meek reported it as abundant throughout the Cayuga lake basin. Large examples are found in Canandaigua lake. One of them measured 14 inches in July 1897. The fish is killed by

warm water. The food in captivity includes hard clam, earth worms, and, occasionally, live killifish.

A. N. Cheney refers to this species on page 215 of the *3d Annual Report of the Commissioners of Fisheries, Game and Forest of the State of New York.*

In Pennsylvania it is the commonest minnow in the Allegheny and Susquehanna basins and is sufficiently common in the Delaware. According to Prof. Cope it reaches 4 pounds in weight and is a fair food fish.

This species is more characteristic of the small streams and clear ponds and it takes the hook very freely; but its proper mission is to serve as bait for the larger and choicer fishes.

Genus TINCA Cuvier

Pseudobranchiae minute; mouth anterior; lips thick but destitute of any horny covering; barbels two, one at either angle of the mouth; pharyngeal teeth in one row, 4 or 5–5 or 4, cuneiform, with a slightly hooked extremity; gill rakers short and lanceolate; dorsal fin rather short, commencing slightly behind the origin of the ventral; anal short; caudal slightly emarginate; scales small, embedded in a thick skin and covered with mucus. Lateral line complete. (After Day)

71 Tinca tinca (Linnaeus)

Tench (Introduced)

Cyprinus tinca LINNAEUS, Syst. Nat. ed. X. I. 321, 1758; LACÉPÈDE, Hist. Nat. Poiss. V, 491, 533, 1800.

Tinca vulgaris CUVIER & VALENCIENNES, Hist. Nat. Poiss. XVI, 322, pl. 484, 1842; HECKEL & KNER, Süssw. Fische, 75, fig. 34, 1858; GÜNTHER, Cat. Fish. Brit. Mus. VII, 264, 1868.

Tinca tinca JORDAN & EVERMANN, Check List Fishes N. A. 512, 1896.

B. 3; D. 12 to 13/8 or 9 developed); P. 17; V. 9–10; A. 9–10. Scales 30 to 31—90 to 115. Length of head four and one third to four and three fourths; hight of body three and three fourths to four and one fourth in the total length including caudal. Eye six and one half to seven and one half in length of head; two and one fourth in length of snout; two to two and one fourth in distance between eyes. Interorbital space flat. The thickness

of the head equals its length exclusive of the snout. Snout obtuse; mouth anterior, jaws anteriorly of the same length, gape wide, cleft rather shallow; the maxilla reaches to beneath the posterior nostril; lips thick. Dorsal origin over the end of the ventral base, and the fin extends almost to above the anal origin; all the fins rounded. In the males the first or even more of the ventral rays are thicker than in the female. Lateral line gradually descending to about the middle of the length, thence proceeding straight to the base of caudal. Leaden or greenish, lightest beneath; fins blackish.

The tench has been introduced into the United States. An individual taken in the Potomac river near Washington D. C. has a grinding surface well developed on the pharyngeal teeth, a character concerning which no mention is made in the current descriptions.

The tench now extends throughout the fresh waters of Europe into those of Asia Minor. Its northern limit is said to be in Finland. It may or may not be native to England. The species prefers still waters in which aquatic plants abound. It is very tenacious of life and has been observed to live a whole day out of water. Its food consists of insects, larvae, worms, and vegetable substances.

Spawning takes place in June and July. The eggs are small and adhesive. The rate of growth is rather rapid under favorable circumstances, the young having attained to a weight of 1 pound in their first year. Individuals of the weight of 10 or 11 pounds are recorded, and Salvianus mentioned a tench of 20 pounds. As for the quality of its flesh, opinions differ, some persons considering it unpalatable, while others regard it as delicious and wholesome.

Genus LEUCISCUS Cuvier

Body oblong, compressed or robust, covered with moderate or small scales; lateral line decurved, complete, or variously imperfect; mouth usually large and terminal, the lips normal, without barbel; teeth mostly 2, 5 4, 2 (in American species some

times 1, 5–4, 2, or even by atrophy, 1, 4–4, 1) usually 2, 5, 5, 2 in the European type, hooked, with rather narrow grinding surface or none; anal basis short or more or less elongate; dorsal fin posterior, usually behind ventrals; intestinal canal short. Size generally large, some species very small. A very large group, one of the largest current genera in ichthyology, represented by numerous species in the rivers of Europe, Asia, and North America. . . Individual irregularities in dentition are common in this genus.

The typical species of the genus, Leuciscus leuciscus, is the common dace or vandoise of Europe, and differs greatly from any of the American forms. The presence of various intermediate species, however, makes it impossible to draw any satisfactory line between the dace, Leuciscus, on the one hand, and such extreme forms as the long-mouthed minnows, Clinostomus, on the other.

Clinostomus is a peculiar group of small, fine-scaled minnows, with the gape of the mouth larger than in any other Cyprinidae whatever. The relationship of the species to those called Richardsonius is however very close. (After Jordan and Evermann)

Subgenus CLINOSTOMUS Girard

72 Leuciscus elongatus (Kirtland)

Red-sided Shiner

Luxilus elongatus KIRKLAND, Rep't Zool. Ohio, 169, 1836; Bost. Jour. Nat. Hist. III, 339, pl. IV, fig. 1, 1841.

Leuciscus proriger GÜNTHER, Cat. Fish. Brit. Mus. VII, 245, 1868.

Squalius elongatus JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 232, 1883.

Phoxinus elongatus BEAN, Fishes Penna. 52, 1893.

Leuciscus elongatus DE KAY, N. Y. Fauna, Fishes, 214, 1842; STORER, Syn. Fish. N. A. 161, 1846; GÜNTHER, Cat. Fish. Brit. Mus. VII, 245, 1868; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 240, 1896.

The red-sided shiner has an elongate fusiform body, its greatest depth two ninths of the total length without the caudal, its greatest width nearly one half of its depth. The caudal peduncle is long and slender, its least depth two fifths of greatest

depth of body. The head is large, two sevenths of total length without the caudal, with long pointed snout and wide mouth. The snout is as long as the eye and two sevenths as long as the head. The width of the interorbital space is about equal to the diameter of the eye. The lower jaw projects strongly. The maxilla reaches to below the middle of the eye. The gill openings are wide, the membranes separated by a very narrow isthmus. The dorsal origin is over the 25th scale of the lateral line; the base of the fin is two fifths as long as the head; the longest ray is as long as the head without the snout; the last ray is about half as long as the longest. The ventral origin is under the 23d scale of the lateral line; the fin extends to the vent, equaling length of eye and snout combined. The anal origin is under the 37th scale of the lateral line; the anal base is two fifths as long as the head; the longest ray twice as long as the last ray and one fourth of its distance from the tip of the snout. The caudal is large and deeply forked. The pectoral is two thirds as long as the head, extending to below the 17th scale of the lateral line. The lateral line is abruptly decurved over the anterior half of the pectoral. D. iii, 7; A. iii, 7; V. 8; P.14. Scales 12–63–7 (sometimes 10–70–5); teeth 2, 5–5, 2, hooked, some of them with a narrow grinding surface. In spirits the color is dark brown; a narrow dark stripe along the middle of the side extending on the head and around the snout; the fins are pale. In life the back is dark bluish, the belly silvery; breeding males have the first half of the lateral stripe crimson and the belly and lower fins rosy. The specimen described, number 8467, U. S. National Museum, from Meadville, Pa., is 3 inches long.

The red-sided shiner is found from Pennsylvania to Minnesota; abundant in clear streams of the Great lakes region and the upper Mississippi valley. In the Lake Ontario basin the U. S. Fish Commission collectors obtained it in the following localities in 1894: Spring brook, Pulaski, July 24; Wart creek, July 24; Three Mile creek, Oswego, July 27.

Subgenus PHOXINUS Rafinesque

73 Leuciscus margarita (Cope)

Pearl Minnow

Clinostomus margarita COPE, Cypr. Penn. 377, pl. 13, fig. 1, 1866.
Squalius margaritus JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 235, 1883.
Phoxinus margaritus BEAN, Fishes Penna. 53, 1893.
Leuciscus margarita GÜNTHER, Cat. Fish. Brit. Mus. VII, 246, 1868; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 241, 1896.

Muzzle obtuse, mouth oblique, scarcely attaining the line of the anterior margin of the orbit; head four times in body to base of caudal fin, equal to greatest depth; eye three fourths its diameter from end of muzzle, and equal to postero-inferior margin of operculum. Scales less exposed on anterior than on posterior regions: 11–58–8 to 9. The lateral line is discontinued 5 to 8 scales anterior to the caudal fin. Pharyngeal teeth slender, 2, 5–4, 2. Dorsal originating behind origin of ventrals, i, 8; A. I, 8; V, 8, extending three fourths from its origin to the anus; P. 17, reaching two thirds way to ventrals.

	Lines
From origin of caudal to first dorsal ray	12
From first dorsal ray to hind margin of orbit	9.5
From first dorsal ray to end of muzzle	13.5
From first anal ray to caudal base	8
From end of muzzle to base of ventrals	12

Total length, 2 inches 6 lines.

Coloration above light olive, without dorsal line, but darker shade at origin of dorsal fin with a minute slaty dusting and a few lateral speckles of the same. Sides to halfway above the lateral line and opercula plumbeous silvery; below bright crimson (in midsummer) to lower margins of pectoral and ventral fins; median line below straw-colored. Muzzle blackish; fins unspotted. (After Cope)

The pearl minnow was supposed to be limited to the Susquehanna river and its tributaries, but it is now known southward to the James and the head waters of the Kanawha, and has

been reported, somewhat doubtfully, from Cemetery creek, at Watertown N. Y. by Dr Evermann.

It is a stout-bodied little species, growing to a length of 3 inches.

Genus IDUS Heckel

Pharyngeal teeth in two series, 3, 5–5, 3, four of those in the principal row laterally compressed and hooked at the tips; lateral line complete; eyes small. Scales small; dorsal and anal fins short, without thickened anterior rays; mouth small, terminal, oblique.

74 Idus idus (Linnaeus)

Golden Ide (Introduced)

Cyprinus idus LINNAEUS, Syst. Nat. ed. X, I, 324, 1758.
Leuciscus idus CUVIER & VALENCIENNES, Hist. Nat. Poiss. XVII, 228, 1844; GÜNTHER, Cat. Fish. Brit. Mus. VII, 229, 1868.
Idus melanotus HECKEL & KNER, Süssw. Fische, 147, figs. 77, 78, 1858.
Idus idus JORDAN & EVERMANN, Check List Fishes N. A. 512, 1896.

Body moderately elongated and compressed; least hight of caudal peduncle two fifths of greatest depth of body, which is two sevenths of total length without caudal; length of head one fourth of total length without caudal; eye large, four times in head and twice in interorbital distance, about as long as the snout; mouth small; jaws equal in length, the maxillary reaching to below the posterior nostril; pharyngeal teeth 5, 3–3, 5, hooked, not serrated; dorsal outline almost regularly arched, similar to ventral outline, top of head slightly flattened; dorsal origin at, or somewhat behind, the middle of the length, directly over the origin of the ventral, its hight nearly equal to length of head; ventrals in advance of dorsal, and extending to the vent; pectorals short, not reaching to ventrals; caudal deeply forked, its lobes equal; lateral line decurved, its second half well below the median line. Vertebrae $26 + 21 = 47$. Reaches a length of 18 or 20 inches and the weight of 6 pounds. D. 11–12; A. 13–14; V. 10. Scales 9 or 10–56 to 59–7, four and one half series between the lateral line and ventral fin.

A variety known as the golden ide, orfe, or gold nerfling has been introduced, for ornamental purposes, into American ponds.

The back and sides are vermillion or orange red; belly silvery; a broad indistinct band of color that runs longitudinally on the tail and divides the deep red of the back. Gums the pale blue of the lower palate; all the rest of these and pale at tips; the tongue red, with a black papil

Genus ABRAMIS Cuvier

Subgenus NOTEMIGONUS Rafinesque

Body subelliptic, strongly compressed; back back and belly curved; back narrowly compressed, almost carinated; belly behind ventrals flat forming a keel over which the scales do not pass. Head small, ovate; mouth small, oblique or horizontal, without barbels; scales rather large; lateral line continuous, strongly decurved; dorsal as inserted behind the ventrals; anal 8; with its base quite or less elongate; teeth 5-5, hooked, with grinding surface; the edges more or less crenate or serrate; alimentary canal short, though rather longer than the body; air bladder large.

Several species, one of them in countries from Nova Scotia to Maryland, west to Dakota, southern to rivers of the South Atlantic states and south to Texas. A peculiar form in Central part, New York only.

71 Abramis crysoleucas (Mitchill)

Shad; Golden shiner

Cyprinus crysoleucus Mitchill, Mem. Fish, N. Y. p. 20. 1814.
Cyprinus auratus Mitchill, Amer. Month. Mag. II. 12. Jan. 1818. Lake George; Lake Champlain.
Leuciscus crysoleucus De Kay, N. Y. Fishes, Fishes III. pl. 92, fig. 90. 1842.
Notropis crysoleucus De Kay & J. Green, Fishes, Atl. pl. 25, fig. 25. 1842.
Abramis americanus Girard, Cat. Fish. Brit. Mus. VII. 201. 1859.
Notemigonus chrysoleucas (Mitch.) A. Gilbert, Bull. U. S. Nat. Mus. No. 1884, Smiths. Check List, p. 21. 1883.
Abramis crysoleucus Jordan & Brayton, Bull. U. S. Nat. Mus. No. 1884, pl. XLV, fig. III. 1883.

The body of the male is compressed, the back elevated and the head depressed and very small. The depth of the body is one third of the total length without the caudal; the head is two-ninths long and two thirds deep at the height. The eye is

[illegible] [illegible] [illegible] [

its favorite shelter is the yellow pond lily. It may be readily distinguished by its shape, which resembles that of the shad, and by the very long anal fin, which contains from 14 to 17 rays. The colors of this fish are greenish above and the sides silvery with golden reflections. Fins usually yellowish; lower fins scarlet in breeding males.

Though the roach is not a good food fish, it is taken by the hook in large numbers and is a very useful species for bait.

The roach, writes Eugene Smith, is an active fish and lives well in the aquarium, becoming very familiar with its keeper. Owing to the small size of its gullet, the smaller individuals will at length starve unless their food is much comminuted. The fish spawned in captivity in May, and early in December of the same year the young were 1½ inches long. The adults do not like earthworms, but feed freely on chopped hard clams.

76 Abramis chrysoleucas roseus *subsp. nov.*

Irish Roach; Pearl Roach

Abramis crysoleucas subspecies, Bean, Bull. Amer. Mus. Nat. Hist. N. Y. IX, 334, 1897.

The "Irish roach" or "pearl roach" of a lake in Central park, New York city, is even more distinct from the typical northern roach than is the subspecies b o s c i of the rivers of the South Atlantic states, and should receive a name. This form is readily distinguished from A. c r y s o l e u c a s by its short and deep body, uniform size of scales on all parts of the body, and the permanent vermilion color of the pectoral, ventral, and anal fins. An example studied in the New York aquarium has D. i, 7; A. i, 12; V. i. 8, scales 10–48–4; teeth 5–5, hooked, crenate, and with a grinding surface. The lateral line apparently is not so strongly decurved as in A. c r y s o l e u c a s.

This is a beautiful fish and extremely shy in captivity. Two females and a male were ready to spawn in the aquarium about the end of June 1896. The females cast their eggs, but they were immediately eaten by the fish.

Genus NOTROPIS Rafinesque

Body oblong or elongate, more or less compressed; mouth normal, mostly terminal and oblique, sometimes subinferior; no barbels; teeth in one or two rows, those of the larger row always 4–4, hooked, sharp edged, or with a narrow grinding surface; scales large, often closely imbricated, those before the dorsal rarely very small; lateral line complete or nearly so, usually decurved; dorsal fin inserted above, or more usually behind, the ventrals; anal fin short or moderately long; abdomen rounded, never sharp edged. Coloration more or less silvery, often brilliant, the males in spring usually with red or white pigment and the head with small tubercles. A very large group of small fishes, specially characteristic of the fresh waters of the eastern United States, containing about 100 species, many of them characterized by extensive individual variations. (After Jordan and Evermann)

77 **Notropis bifrenatus** (Cope)

Bridled Minnow

Hybopsis bifrenatus COPE, Cypr. Penna. 384, 1866; GÜNTHER, Cat. Fish. Brit. Mus. VII, 211, 1868 (as a doubtful species).

Hemitremia bifrenata JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 162, 1883.

Notropis bifrenatus JORDAN, Check List Fishes N. A. 22, 1885; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 258, 1896.

Front convex between the orbits; length of muzzle equals diameter of iris band and pupil, sometimes nearly equals orbit. Iris colored in continuation of the lateral band. The lateral line rarely extends half way to the dorsal fin, while the pores of the same may be observed at the bases of the scales for half the remaining length of the animal. Length of the largest specimen, 19 lines; breadth of muzzle at nares, 1.5 lines. Radii of the scales strong.

Color above straw, the scales delicately brown edged; below impure white, with a narrow black line along base of anal fin to caudal. Along each side from caudal fin around the end of muzzle including the end of the mandible, a shining black band

one and one half scales in width. This is bordered above on the muzzle, forming an arc from orbit to orbit, by an orange band, which is strongly margined above by the brown of the top of the front. Opercular and suborbital regions below the black band, pure silvery. (Rearranged from Cope)

Head four and one fifth; depth four and one fifth; eye three. D. 8; A. 7. Scales 5-36-3; teeth 4-4. Body rather slender, the caudal peduncle somewhat contracted; head moderate, the muzzle very obtuse; mouth oblique, the jaws about equal, upper lip opposite lower part of pupil; eye large, longer than snout; lateral line developed for a very short distance. 13 scales before dorsal. Length $1\frac{1}{2}$ to 2 inches.

This little minnow has no common name. It is found from Massachusetts to Maryland and is abundant in tributaries of the Delaware river. On account of its conspicuous colors, it is a useful bait for game fishes, specially the black bass.

78 Notropis anogenus Forbes

Notropis anogenus Forbes, Bull. Ill. Lab. Nat. Hist. 138, 1885; Meek, Ann. N. Y. Acad. Sci. IV, 304, 1888, Canal near Montezuma, N. Y.; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 259, 1896.

Head four and one fourth; depth four and two fifths; eye three and one fourth. D. 8; A. 7. Lateral line 34 to 37, 13 before dorsal. Teeth 4–4. Very similar to N. h e t e r o d o n, but with the lateral line usually complete; the mouth very small and very oblique, almost wholly anterior; the lower jaw included, the upper lip above level of pupil; snout very short, blunt, shorter than eye. Dusky; a dusky lateral band through eye, ending in a faint black spot at base of caudal; a black speck above each pore of lateral line; chin black. Length $1\frac{1}{2}$ inches. Western New York (Cayuga lake, Meek) to northern Illinois; rather scarce. (After Jordan and Evermann)

According to Meek the species is quite common in the canal near Montezuma N. Y. It is the smallest of all the Cayuga lake fishes.

79 Notropis cayuga Meek

Notropis cayuga Meek, Ann. N. Y. Acad. Sci. IV, 305, 1888, Cayuga Lake, N. Y.; Jordan, Bull. U. S. F. C. IX, 17, 1891; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 260, 1896.

Head four and one sixth; depth four and one half; eye three and one half. Scales 36; before dorsal 14. Teeth 4–4. Allied to N. h e t e r o d o n, from which it may be best known by the absence of black on the chin. Lateral line wanting on some scales; mouth very small, anterior, the maxillary not reaching the eye; jaws subequal; eye large, equal to snout. Scales above dark edged, the outlines very sharply defined; chin not black; a black stripe through snout and eye, a dusky lateral shade and a small caudal spot. Length $2\frac{1}{2}$ inches. Cayuga lake and northern New York, westward to Assiniboia, South Dakota, Nebraska, Kansas and Arkansas. Not rare, but hitherto usually confounded with N. h e t e r o d o n. (After Jordan and Evermann)

Several examples were taken by Dr Meek near Ithaca. The longest was $2\frac{2}{5}$ inches. He also obtained it from the canal near Montezuma N. Y.

The U. S. Fish Commission parties secured this minnow in many localities in 1894.

Mouth of Little Salmon creek	July 25
Chaumont river	July 10
Black creek, tributary of Oswego river	July 17
Three Mile creek, Oswego	July 27
Great Sodus bay	Aug. 6
Guffon creek, Chaumont	July 7
Four Mile creek, Nine Mile point, Webster	Aug. 9
Cemetery creek, Watertown	July 5
Mud creek, Cape Vincent	June 25
Mill creek, Sacketts Harbor	July 2

80 **Notropis heterodon** (Cope)

Alburnops heterodon Cope, Proc. Ac. Nat. Sci. Phila. 281, 1864.
Hybopsis heterodon Cope, Cypr. Penna. 382, 1866.
Leuciscus heterodon Günther, Cat. Fish. Brit. Mus. VII, 261, 1868.
Hemitremia heterodon Jordan, Man. Vert. 303, 1878; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 163, 1883.
Notropis heterodon Jordan, Cat. Fish. N. A. 22, 1885; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 261, 1896.

Head four; depth four; eye three in head. D. 8; A. 8. Scales 5–36–3, the lateral line extending about half the length of

body; teeth 4 4, often crenate. Body moderately stout, the back somewhat elevated; head rather pointed, the muzzle acuminate; mouth oblique, lower jaw projecting, upper lip opposite upper rim of pupil; maxillary extending to opposite front of orbit; 13 scales in front of dorsal; lateral line usually more or less imperfect. Color olivaceous; chin black; a blackish rostral band; sides with a leaden or dusky band. Length 2½ inches. New York to Michigan and Kansas, common. Variable. (After Jordan and Evermann)

Common in all the sluggish water on the flats near Ithaca. Not found at the north end of the lake, where it seems to be replaced by Notropis anogenus. *Mock*

The U. S. Fish Commission collectors have obtained it at Cape Vincent N. Y. June 21, Stony Island, July 2 and 3, and at Guffon creek, Chaumont, July 7, 1894.

81 Notropis blennius (Girard)

Straw-colored Minnow

Alburnops blennius Girard, Proc. Ac. Nat. Sci. Phila. 194. 1856. Pacific R. R. Surv. X, 261, pl. 57, figs. 13-16, 1858.
Minnilus blennius Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 193. 1883.
Notropis blennius Jordan, Cat. Fish. N. A. 24. 1885; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 261, 1896.

Body slender, elongate, its greatest depth one fifth of total length without caudal; head rather large, one fourth of total length without caudal; the eye large, a little longer than snout, one third as long as the head; mouth small, inferior, horizontal, the maxilla reaching to front of orbit; snout very obtuse; dorsal a little nearer to tip of snout than to base of caudal, its origin about over end of pectoral, its longest ray three fourths as long as the head; teeth 4–4; 13 to 15 rows of scales before dorsal. The ventral is under the base of the dorsal, its length equal to length of head without snout. D. 8 to 9; A. 7 to 8. Scales 5 to 6–32 to 38–4.

Color pale olivaceous; sides usually pale; usually a darker dorsal band and a small dark blotch before dorsal, sometimes a plumbeous lateral stripe but no caudal spot; fins all plain. Length 2 to 2½ inches.

This small minnow is found in the Great lakes region, westward to Dakota and south to Texas. The U. S. Fish Commission collectors secured a moderate number of specimens in 1894 at the following localities.

Cape Vincent	June 23
Grenadier island	June 27
Little Stony brook, Henderson bay	July 4
Big Sandy creek, Belleville	July 12
Mouth Salmon river, Selkirk	July 25
Great Sodus bay	Aug. 6

Dr B. W. Evermann and Barton A. Bean secured 12 examples in Scioto creek, Coopersville N. Y. July 19, 1894. They also took many specimens July 17 in the St Lawrence river, 3 miles below Ogdensburg N. Y. Dr Evermann observed a diffuse plumbeous band along the side, each scale in the lateral line punctate with black, making the lateral line very conspicuous. In many a very small black spot was present at base of caudal. The dorsal was very low, only five ninths length of head.

82 **Notropis procne** (Cope)

Shiner

Hybognathus procne Cope, Proc. Ac. Nat. Sci. Phila. 279, 283, 1864.
Hybopsis procne Cope, Cypr. Penna. 385, pl. XI, fig. 2, 1866.
Leuciscus procne Günther, Cat. Fish. Brit. Mus. VII. 260, 1868.
Cliola procne Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 169, 1883.
Notropis procne Jordan, Cat. Fish. N. A. 23, 1885; Bean, Fishes Penna. 37, 1893; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 264, 1896.

This little minnow has a short, slender and compressed body and a very slender caudal peduncle. The greatest depth, at the dorsal origin equals the length of the head, which is about one fourth of the total without caudal. In some described specimens the head is contained four and three fourths times and the depth of the body five and one fourth times in total length without caudal. The snout is short and obtuse, shorter than the eye, which is two fifths as long as the head. The mouth is terminal and small, the maxilla not reaching to front of eye, and the jaws equal. The lateral line is gently curved down-

ward over the pectoral and, in the specimen examined, becomes interrupted in its posterior half. The dorsal origin is over the 12th scale of the lateral line and nearly over the ventral origin. The dorsal base is a little more than half as long as the head, and the longest ray is as long as the head. The ventral reaches to the anal origin. The anal base is half as long as the head and the longest anal ray is four fifths as long as the head. The caudal is moderately forked. D. 8; A. 7; V. 8; P. 13. Scales 5–32 to 34 3; teeth 4 4. Length of specimen described, from Havre de Grace Md., 2¼ inches. Color in spirits light brown, the belly pale and lower half of head silvery. A narrow dark line along the top of the back and a narrow dark median band continued forward on the nose. Fins all pale. In life the body is olivaceous with a dark lateral stripe. The long tail suggests the name p r o c n e, a kind of swallow.

The shiner is found from western New York to Maryland. Prof. Cope found it abundant in the tributaries of the Delaware and Susquehanna, in slow moving streams. It reaches the length of 2½ inches.

Eugene Smith records it as "very plentiful in the small brooks directly running into tide water. It appears to approach the sea more closely than any other minnow, though it is never found in brackish water. It delights in strong currents, but in captivity lives well in the aquarium, feeding voraciously. It is almost entirely carnivorous. The Palisade ridge is probably the furthest limit of this species towards the east. It is met with in company of the suckers and the roach."

It has proved an excellent bait for the game fishes.

83 **Notropis hudsonius** (DeWitt Clinton)

Spawn-eater; Smelt

Clupea hudsonia De Witt Clinton, Ann. Lyc. Nat. Hist. N. Y. I. 49. pl 2, fig. 2, 1824 (*fide* Günther).

Leuciscus hudsonius De Kay, N. Y. Fauna, Fishes, 206, pl. 34, fig. 109, 1842 (Hudson river and tributaries)

Hybopsis hudsonius Cope, Cypr. Penna. 386, pl. 12, fig. 3, 1866.

Cliola hudsonia Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 171, 1883.

Notropis hudsonius JORDAN, Cat. Fish. N. A. 24. 1885; BEAN, Fishes Penna. 38. 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 269. 1896. pl. XLVII, fig. 119.

The spawn-eater has a moderately elongate and compressed body, its greatest hight contained four and one half times in the total length without caudal, and about equal to length of head. The head is conical, with short, blunt snout equal to the diameter of the eye, which is contained three and one half times in the length of the head. The space between the eyes equals length of postorbital part of head. Mouth small, nearly horizontal, the lower jaw very slightly the shorter, the maxilla reaching the vertical through the posterior nostril. The lateral line is slightly curved downward over the pectoral, straight and median for the rest of its course. The origin of the dorsal is over, and of the ventral under, the 13th scale of the lateral line. The dorsal base is two thirds as long as the head, and the longest ray as long as the head. The ventral reaches nearly or quite to the vent. The anal origin is under the 24th scale of the lateral line; the anal base is one half and the longest anal ray four fifths as long as the head. The caudal is large and deeply forked, its middle rays half as long as the outer. D. 8; A. 8 or 9; V. 8; P. 14. Scales 7–38–5; teeth 2, 4–4, 1 or 2, with a narrow grinding surface on at least two. Length of specimens described from Washington D. C. $3\frac{1}{2}$ to $4\frac{1}{4}$ inches. Color in spirits pale brown, the fins and all of head except upper surface pale; a broad median silvery band, its greatest width about equal to diameter of eye; a dusky spot at the root of the caudal in the young.

The spawn-eater is said to occur from Lake Superior to New York and southward. In Pennsylvania begins a form elsewhere described as N. amarus, which differs in the structure of the pharyngeal teeth.

This minnow does not much frequent small streams, but is abundant in the Delaware river and also in Lake Erie. De Kay records its occurrence in the Hudson and its tributaries.

In the Lake Ontario region the U. S. Fish Commission collectors obtained numerous specimens in these localities.

Salt brook, 1½ miles above Nine Mile point	June 10 11, 1893
Cape Vincent	June 21, 1894
Grenadier island	June 27, 1894
Horse island, Sacketts Harbor	June 30, 1894
Mouth Salmon river, Selkirk	July 25, 1894
Three Mile creek, Oswego	July 27, 1894
Great Sodus bay	Aug. 6, 1894
Long pond, Charlotte	Aug. 17, 1894
Lake shore, mouth Long pond	Aug. 17, 1894
Nine Mile point, Webster	Aug. 23, 1894
East end Lake Ontario	1894

Livingston Stone also collected the species at Cape Vincent Aug. 9, 1898.

In the Lake Champlain basin Evermann and Bean obtained it at Scioto creek, Coopersville, and Rouse Point July 19, 1894.

The spawn-eater reaches the length of 10 inches. Its teeth are usually four in the principal row and two in the inner. Its spawn-eating habits are not verified.

84 Notropis hudsonius amarus (Girard)

Gudgeon

Hudsonius amarus GIRARD, Proc. Ac. Nat. Sci. Phila. 210, 1856. (Chesapeake Bay; Potomac river at Washington)
Hybopsis storerianus COPE, Cypr. Penna. 386, 1866.
Leuciscus storerianus GÜNTHER, Cat. Fish. Brit. Mus. VII, 250, 1868; KIRTLAND, Bost. Jour. Nat. Hist. V, 30. pl. IX, fig. 2, 1847.
Cliola storeriana JORDAN & GILBERT, Bull. 16. U. S. Nat. Mus. 170, 1883.
Notropis amarus BEAN, Fishes Penna. 39, pl. 23, fig. 37, 1893.
Notropis hudsonius amarus JORDAN, Cat. Fish. N. A. 24, 1885; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 270, 1896.

The gudgeon has a moderately elongate and compressed body and a slender caudal peduncle. The greatest depth equals one fourth of the total length to base of caudal, and the least depth of the peduncle equals the length of the postorbital part of head. The head is rather short with an obtuse short snout: the length of the head is nearly one fourth of the total to base of caudal. The snout is one fourth and the eye one third as long as the head. The maxilla extends to the vertical through the front of

the eye; the lower jaw is slightly included; the mouth is slightly oblique. The width of the head equals nearly two thirds of its length. The distance between the eyes equals the length of the orbit. The dorsal origin is over, and the ventral origin under, the 10th scale of the lateral line. The length of the dorsal base equals two thirds that of the head, and the longest dorsal ray is four fifths as long as the head. The anal base is as long as the postorbital part of the head and the longest ray is about two thirds as long as the head. The ventral reaches nearly to the vent, and the pectoral to below the 8th scale of the lateral line. The lateral line is very slightly bent downward over the pectoral. The caudal is moderate in size and deeply forked. D. ii, 7; A. ii, 7; V. 8; P. 15. Scales 6–36 to 39–4; teeth 1, 4–4, 1 or 1, 4–4, 0 in the example described, from the Susquehanna river. Length $4\frac{1}{4}$ inches. The teeth are slightly hooked, and two or three on each side have a developed grinding surface. The color in spirits is light brown, the sides of body and lower half of head silvery; the young have a narrow dusky median lateral band, which is sometimes continued on the snout, and a more or less distinct small dark blotch at the base of the caudal. The fins are all pale.

The gudgeon or smelt of Pennsylvania is a variety of N. hudsonius of Clinton, which ranges from Lake Superior to New York and south in streams east of the Alleghanies to Georgia. The southern form is the variety amarus of Girard, which exhibits some difference in its pharyngeal teeth. The species is an extremely variable one. It grows to a length of about 8 inches. Prof. Cope records it as abundant in the Susquehanna, specially in the lower part of the river.

This is a handsome silvery fish, and is as much used for food as its associate, the silvery minnow.

85 **Notropis whipplii** (Girard)

Silverfin

Cyprinella whipplii Girard, Proc. Ac. Nat. Sci. Phila. 198, 1856.
Photogenis spilopterus Cope, Cypr. Penna. 378, 1866.
Leuciscus spilopterus Günther, Cat. Fish. Brit. Mus. VII, 254, 1868.

Luxilus kentuckiensis KIRTLAND, Bost. Jour. Nat. Hist. V. 27, pl. VIII, fig. 3, 1847.
Hypsilepis kentuckiensis COPE, Cypr. Penna. 371, 1866.
Cliola whipplei JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 178, 1883.
Cliola analostana JORDAN & GILBERT, *op. cit.* 179, 1883.
Notropis whipplei BEAN, Fishes Penna. 39, 1893.
Notropis whipplii JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 278, 1896, pl. XLVIII, fig. 121, 1900.

The silverfin has a moderately elongate body, which is fusiform in the adult. The caudal peduncle is short and stout. The depth of the body at the ventral fin equals nearly one fourth of the total length to the caudal base. The head is conical, compressed and with a pointed snout a little longer than the eye, which is two ninths as long as the head. The mouth is moderate, terminal, slightly oblique, the jaws nearly equal, the maxilla reaching to vertical through front of eye. The head is two ninths of the total length without caudal. The dorsal origin is a little behind the ventral origin and over the 15th scale of the lateral line. The length of the dorsal base equals one seventh of the total without caudal, and the longest ray is as long as the head without the snout. The ventral reaches nearly to the anal. The anal begins under the 21st scale of the lateral line; its base is as long as the dorsal base, and its longest ray is about two thirds as long as the head. The caudal is large and moderately forked. The lateral line curves downward over the pectoral. D. 8; A. 9; V. 8; P. 14. Scales 6-38 to 41-4; teeth 1, 4-4, 1, with more or less serrate edges. Length of specimen described, from the Susquehanna river, 4 inches.

In spirits the back is brown, the sides dull silvery, the scales with a dusky margin, and the lower parts are whitish. A narrow and long black blotch on the membrane between the 6th and 7th and another between the 7th and 8th dorsal rays. Lower fins pale. Males in spring have the fins partly or wholly charged with white pigment, and in the hight of the breeding season the pigment in the dorsal has a greenish tint, and the top of the head and snout is covered with minute tubercles.

This is one of our finest minnows for the aquarium and is useful as food and bait for larger fishes.

The silverfin ranges from western New York to Virginia and west to Minnesota and Arkansas. It is a common and variable species. It reaches a length of 4 inches. In Pennsylvania it occurs in all the rivers and creeks, but according to Prof. Cope is least common in tributaries of the Delaware.

According to Dr Meek it is common on flats near Fall creek and in the southern end of Cayuga lake. Evermann and Bean took it in Scioto creek, Coopersville N. Y. in July 1894. In the Lake Ontario region the U. S. Fish Commission secured the following specimens:

Grenadier island	June 27, 1894
Horse island, Sacketts Harbor	June 30, 1894
Cape Vincent	June 21, 1894
Mill creek, Sacket Harbor	July 2, 1894
Cemetery creek and Black river, Watertown	July 5, 1894
Chaumont river	July 10, 1894
Great Sodus bay	Aug. 6, 1894
Creek near Pultneyville	Aug. 7, 1894

Specimens were obtained also by Livingston Stone at Cape Vincent Aug. 9, 1898, and presented to the State Museum.

Subgenus LUXILUS Rafinesque

86 **Notropis cornutus** (Mitchill)

Shiner; Redfin

Cyprinus cornutus MITCHILL, Amer. Month. Mag. I. 289. July, 1817. (meager preliminary notice); *op. cit.* II, 324, Feb. 1818. (Wallkill river, N. Y.)

Cyprinus megalops RAFINESQUE, Amer. Month. Mag. II, 121, Dec. 1817. (Hudson river, above the falls)

Leuciscus vittatus DE KAY, N. Y. Fauna, Fishes, 212, pl. 34, fig. 108, 1842. (Chittenonda and other tributaries of the Mohawk; also in Mohawk)

Hypsilepis cornutus COPE, Proc. Ac. Nat. Sci. Phila. 158, 1867.

Leuciscus cornutus DE KAY, N. Y. Fauna, Fishes, 207, pl. 29, fig. 92, 1842; GÜNTHER, Cat. Fish. Brit. Mus. VII, 249, 1868.

Minnilus cornutus JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 186, 1883.

Minnilus plumbeolus JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 192, 1883.

Notropis megalops JORDAN, Cat. Fish. N. A. 26, 1885; BEAN, Fishes Penna. 40, 1893.

Notropis cornutus JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 281, 1896.

The redfin when young has the body moderately elongate, but it becomes deeper with age and much compressed. The caudal peduncle is short, and its depth equals length of postorbital part of head. The depth of the body at the ventral is contained three and one third to four times in the total length without the caudal. The head is short, deep and thin, its length one fourth of the total without caudal, its width about one half its length. The eye is as long as the snout and two sevenths as long as the head. Mouth moderate, terminal, oblique, the maxilla reaching about to vertical through front of eye. The dorsal origin is over, and the ventral origin under, the 12th scale of the lateral line. The length of the dorsal base equals one seventh of the total without the caudal, and its longest ray one fifth of the same length. The ventral reaches nearly or quite to vent. The anal origin is under the 23d scale of the lateral line. The anal base is one half, and the longest ray two thirds as long as the head. The caudal is large and deeply forked. The lateral line descends in a long curve, becoming straight and median over the anal origin. D. 8; A. 9; V. 8; P. 15. Scales 7 40 to 41 4; teeth 2. 4 4. 2, with narrow grinding surface. Length of specimens described, from 4 to 4½ inches.

The upper parts of this fish are steel blue and the scales are dusky at the edge and base. The sides are silvery, overlaid with a gilt line; there is another gilt band along the back. The belly is silvery except in spring males, in which it is a bright rosy color. The male in the breeding season has the lower jaw and the top of the head and nape covered with small tubercles. In the breeding condition this is a very handsome species, though the females and young lack the bright colors of the adult male.

The redfin is known also as the common shiner, dace, roughhead, and banded dace. It is a very widely distributed species, is extremely variable, and, as a consequence, some geographic races have received distinct names. It extends from Maine to the Rocky mountains, but is absent from the Carolinas and Texas. It grows to a length of 8 inches. In Pennsylvania the species is common everywhere and is best known under the name of redfin. It reaches a very large size in Lake Erie.

In New York Mitchill had it from the Wallkill; Rafinesque from the Hudson above the falls. De Kay knew it from the Mohawk and some of its tributaries including the Chittenonda. Dr Meek found it very common throughout the entire Cayuga lake basin. Evermann and Bean collected it in the Saranac river, Plattsburg, July 28, and in Scioto creek, Coopersville, July 19, 1894. They secured it also in the St Lawrence river, 3 miles below Ogdensburg, July 17, 1894. The U. S. Fish Commission field parties found it very common in the Lake Ontario basin 1892 to 1894, specimens having been recorded from: Sacket Harbor, Charlotte, Huntingtonville, Henderson Harbor, Cape Vincent, Pulaski, Oswego, Pulneyville, Pointbreeze, Webster, Belleville, Scriba Corners, Wart creek, North Hamlin and Salt brook.

The redfin runs into small brooks and is most abundant in eddies and other quiet parts of the streams. It has no value except as food and bait for larger fishes, specially the black bass and pike perch. The flesh is very soft and decays rapidly after death.

87 Notropis cornutus frontalis (Agassiz)

Leuciscus frontalis AGASSIZ, Lake Superior, 368, pl. 3, fig. 4, 1850, or *Hypsolepis frontalis fide* GÜNTHER.

Hypsilepis cornutus gibbus COPE, Proc. Ac. Nat. Sci. Phila. 158, 1867.

Minnilus cornutus var. *frontalis* JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 187, 1883.

Notropis megalops frontalis MEEK, Ann. N. Y. Ac. Sci. IV, 307, 1888.

Notropis cornutus frontalis JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 283, 1896.

Very close to the typical cornutus, differing in its very heavy head and in the smaller number of scales (13 to 18) in advance of the dorsal. Great lakes; everywhere common in mouths of brooks. Dr Meek found it scarce near Ithaca and common near Montezuma N. Y.

Subgenus NOTROPIS

88 Notropis atherinoides Rafinesque

Emerald Minnow; Rosy Minnow

Notropis atherinoides RAFINESQUE, Amer. Month. Mag. II, 294, Jan. 1818.

Alburnus rubellus AGASSIZ, Lake Superior, 364, pl. 3, figs. 1-3, 1850.

Leuciscus rubellus GUNTHER, Cat. Fish. Brit. Mus. VII, 254, 1868.

Minnilus rubellus and *dinemus* JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 202, 1883.

Notropis atherinoides JORDAN, Cat. Fish. N. A. 27, 1885; MEEK, Add. N. Y. Acad. Sci. IV, 308, 1888; BEAN, Fishes Penna. 44, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 293, 1896.

The emerald minnow or rosy minnow has a long and thin body and the caudal peduncle moderately short and deep. The greatest depth of the body is contained four and three fourths to five and one half times in the total length to caudal base; the least depth of the caudal peduncle is contained 11½ times in the same length. The greatest width of the body is one half its hight. The head is of moderate size, its length two ninths of the total to caudal base. The snout is short and somewhat pointed, its length one fourth that of the head. Eye large, about three and one fourth times in length of head; mouth oblique, moderate, the maxilla reaching front of eye. The dorsal origin is midway between the eye and the base of the caudal, over the 17th scale of the lateral line. The base of the fin is two fifths as long as the head, and the longest ray equals the length of the head without the snout. The ventral origin is under the 13th scale of the lateral line, and the fin scarcely reaches to below the end of the dorsal base. The pectoral reaches to below the eighth or ninth scale of the lateral line. The anal origin is under the 24th scale of the lateral line; the base is one half as long as the head, and the longest ray equals the snout and eye combined. The caudal is rather large and deeply forked. The lateral line sweeps downward in a long and shallow curve, becoming nearly median over the anal base. D. ii, 7; A. ii, 9; V. 8; P. 14. Scales 6 39-4; teeth 2, 4-4, 2 or 1, some of them with a slight hook and narrow grinding surface. The specimens described (no. 8735, U. S. National Museum) are 4 to 4½ inches long. In spirits the upper parts are light brown, the sides and cheeks silvery, and the belly golden brown; the fins all pale; the width of the silvery stripe equal to diameter of eye. In life the upper parts are greenish; breeding males have the snout rosy.

The emerald minnow is found in the Great lakes region, the Ohio valley and south to Tennessee, being abundant in lakes

and in rapids of rivers. The variety found in Pennsylvania has a shorter snout and a smaller eye than the typical atherinoides and has received the specific name dinemus; but the differences are not supposed to be constant. The emerald minnow reaches a length of 6 inches; it is gregarious like other minnows; and its golden lateral stripe on a clear green ground makes it a handsome species.

Dr Meek found one example near Ithaca, in Six Mile creek, below the falls. A few specimens were also found in a small stream near Montezuma dry dock, in company with N. lythrurus. Evermann and Bean caught a single example in Scioto creek, Coopersville, July 19, 1894; also three specimens in the St Lawrence river, 3 miles below Ogdensburg July 17, 1894. At Cape Vincent June 21, 1894, the U. S. Fish Commission collectors took 29 specimens, and at Grenadier island, June 27, they obtained 14 individuals. Livingston Stone also collected the species at Cape Vincent Aug. 9, 1898, and presented specimens to the State Museum.

89 **Notropis rubrifrons** (Cope)

Rosy-faced Minnow

Alburnus rubrifrons Cope, Proc. Ac. Nat. Sci. Phila. 85, 1865.
Alburnellus rubrifrons Cope, Cypr. Penna. 388, pl. XIII, fig. 3, 1866.
Leuciscus rubrifrons Günther, Cat. Fish. Brit. Mus. VII, 255, 1868.
Minnilus rubrifrons and *percobromus* Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 202, 1883.
Notropis dilectus Bean, Fishes Penna. 44, 1893.
Notropis rubrifrons Jordan, Cat. Fish. N. A. 27, 1885; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 295, 1896.

The rosy-faced minnow has the body moderately long and thin, with a short and deep caudal peduncle. The greatest depth of the body equals one fourth, and the least depth of the peduncle, one eighth of the total length to base of caudal. The head is moderate in size; its width one half of its length, which is one fourth of the total to base of caudal. The snout is pointed and shorter than the eye, which is one fourth to two sevenths as long as the head and equal to the distance between the eyes. The mouth is oblique, and the lower jaw projects slightly; the

maxilla reaches nearly to below the front of the pupil. The dorsal origin is over the 15th, and the ventral origin under the 12th scale of the lateral line. The base of the dorsal is half as long as the head, and the longest dorsal ray equals the length of the head without the snout. The ventral reaches to the vent, which is under the 18th scale of the lateral line. The anal base is as long as the snout and eye combined, and the longest anal ray is two thirds as long as the head. The caudal is moderate in size and deeply forked. The lateral line curves gently downward over the pectoral. D. ii, 7; A. ii, 8; V. 8; P. 13. Scales 6–36–4; teeth 2, 4 4, 2, hooked. The specimens described are 2 inches long. In spirits the body is pale brown; a silvery shade along the median line; the head silvery except above; belly golden; fins all pale. In life the upper parts are olive green and the sides silvery. Males in the breeding condition in spring have prickles on the snout and the forehead; gill covers and dorsal base with a rosy flush. The name d i l e c t u s means delightful.

The rosy-faced minnow, though reaching a length of only 3 inches or less, is a very beautiful fish. It is abundant in the Ohio valley and extends westward to Nebraska. This is the A l b u r n e l l u s r u b r i f r o n s of Cope.

The U. S. Fish Commission collections of 1894 contain this minnow from Salt brook, 1½ miles above Nine Mile point June 11, Mill creek, Sacket Harbor July 2, Wart creek July 24, Sandy creek, North Hamlin Aug. 20.

Evermann and Bean secured it in abundance in Racquette river, Norfolk, July 18, 1894, and they had a few specimens from Scioto creek, Coopersville, July 19, 1894.

90 Notropis amoenus (Abbott)

Alburnellus amœnus Abbott, Amer. Nat. VIII, 334, 1874. Raritan River, N. J.

Notropis amœnus Jordan, Bull. U. S. Fish Com. XIII, 102, 1891; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 296, 1896.

Head four; depth five and one third (four and three fourths to five and one half); eye three and one third. D. 8; A. 10. Scales

6–39–3. Close to Notropis rubrifrons, but the scales before dorsal smaller, as in N. photogenis. Body elongate, compressed; eye large, longer than snout; mouth large, oblique, the jaws subequal, the maxillary reaching to below front of eye; 22 to 25 (rarely 18 to 20) scales before dorsal; lateral line much decurved; dorsal high, placed behind ventrals; pectorals moderate. Translucent green, sides silvery, with sometimes a faint plumbeous band ending in an obscure plumbeous spot. Length $3\frac{3}{4}$ inches. Clear streams east of the Alleghanies from the Raritan to the Neuse; abundant; formerly confounded with N. photogenis, of which it may be a variety. (After Jordan and Evermann)

Eugene Smith[1] says it is perhaps a variety of N. photogenis (Cope). Abbott mentions it from the Raritan river, near New Brunswick N. J.

91 Notropis umbratilis lythrurus Jordan

Redfin

Notropis lythrurus Jordan, Proc. U. S. Nat. Mus. 476, 1884.
Hypsilepis diplaemia Cope, Proc. Ac. Nat. Sci. Phila. 162, 1867.
Minnilus diplaemius Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 197, 1883.
Luxilus lucidus Girard, Pacific R. R. Surv. Fishes, 282, pl. LX, figs. 9-12, 1858.
Notemigonus lucidus Jordan & Gilbert, op. cit. 249, 1883.
Notropis lythrurus Meek, Ann. N. Y. Ac. Sci. IV, 307, 1888.
Notropis umbratilis lythrurus Jordan & Evermann Bull. 47, U. S. Nat. Mus. 300, 1896.

Head four and one fourth; depth four to four and one half; eye three to four. D. 7; A. 11. Scales 9–40 to 52–3; teeth 2, 4–4, 2. Body compressed, the caudal peduncle long; head long, conical, rather pointed; mouth large, moderately oblique, the premaxillary on level of pupil, the maxillary reaching to below eye; lower jaw somewhat projecting; eye moderate, about equal to muzzle; scales closly imbricated, crowded anteriorly, about 30 before dorsal; dorsal fin high, inserted about midway between ventrals and anal; pectorals not reaching ventrals;

[1]Linn. Soc. N. Y. Proc. 1897. no. 9, p. 18.

ventrals reaching to vent; caudal fin long. Coloration dark steel blue above; pale or silvery below; a more or less evident black spot at base of dorsal in front; the fins otherwise all plain. Males with the anterior dorsal region and the head profusely covered with small whitish tubercles, the belly and lower fins being of a bright brick red in the spring. Females very pale olive, sometimes almost colorless. Length 3½ inches. Minnesota to western New York (Cayuga lake), North Carolina, Alabama, and Kansas; generally abundant in small, clear streams. (After Jordan and Evermann)

Dr Meek took a single specimen from a small stream near the Montezuma dry dock.

Genus RHINICHTHYS Agassiz

Body moderately elongate and little compressed, with usually stout caudal peduncle and long, conical nose; head rather large, sometimes broad and flat above; eye small; mouth small, subinferior, the upper jaw fixed by the union of the upper lip to the skin of the forehead; end of maxillary with a small barbel. Teeth 2, 4 4, 2 (sometimes 2, 4 4, 1) those of the principal row usually hooked, without grinding surface. A short intestinal canal; scales very small; lateral line decurved, continuous; dorsal origin slightly behind ventral; base of anal short. Small fishes inhabiting clear, cold brooks and streams.

92 Rhinichthys cataractae (Cuv. & Val.)

Long Nosed Dace; Niagara Gudgeon

Gobio cataractae CUVIER & VALENCIENNES, Hist. Nat. Poiss. XVI, 315, pl. 483 (poor), 1842 (specimen 5 inches long, from Niagara Falls, N. Y., Milbert); DE KAY, N. Y. Fauna, Fishes, 394; 1842. (After Cuvier and Valenciennes)

Leuciscus nasutus AYRES, Bost. Jour. Nat. Hist. IV, 299, pl. XIII, fig. 3 (very bad), 1844. West Hartford, Conn. Specimen 5¼ inches long.

Rhinichthys marmoratus AGASSIZ, Lake Superior, 354, pl. 2, figs. 1-2, 1850; GUNTHER, Cat. Fish. Brit. Mus. VII, 189, 1868.

Rhinichthys nasutus GUNTHER, op. cit. VII, 189.

Argyreus nasutus COPE, Cypr. Penna. 369, pl. XII, fig. 5, 1866.

Ceratichthys cataractae GUNTHER, op. cit. VII, 176, 1878.

Rhinichthys cataractae JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 207, 1883; BEAN, Fishes Penna. 46, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 306, 1896.

The long nosed dace has a moderately elongate body, with short and stout caudal peduncle and a moderate sized head. The greatest depth is contained four and two thirds times in the total length without caudal; the least depth of the caudal peduncle eight and one half times. The width of the body equals the combined length of snout and eye. The length of the head is one fourth of the total without caudal and three times the length of the snout. The eye is placed high, one fifth to one quarter as long as the head and about two thirds as long as the interorbital width. The mouth is horizontal, small, placed under the snout, the lower jaw the shorter, the upper lip thick and provided with a small barbel at each end. The maxilla reaches to below the posterior nostril. The dorsal origin is above the 23d scale of the lateral line, and the ventral origin is under the 20th. The dorsal base is one half, and the longest ray four fifths as long as the head. The ventral reaches a little beyond the vent and almost to the anal origin. The pectoral reaches nearly or quite to the origin of the ventral, being longer in males. The anal origin is under the 34th scale of the lateral line and a little behind the end of the dorsal. The anal base is one half, the longest ray three fourths as long as the head. The caudal is comparatively large and well forked. The lateral line drops gently downward in a short curve over the pectoral and becomes median over that fin. D. ii, 7; A. ii, 6; V. 8; P. 12. Scales 13–57 to 65–10; teeth 2, 4–4, 2, three of the principal row hooked. Length of the specimen described (no. 8505, U. S. National Museum) 3½ inches.

In spirits the color is brown mottled with grayish; the under surface of head sharply defined and pale; the fins all pale. Breeding males in spring have the lips, cheeks and lower fins crimson. The sides are without a black lateral band, which is characteristic of the black nosed species. The general color is olivaceous or dark green with the lower parts paler. The back is nearly black. Some of the scales are mottled with dark and olivaceous. The young have a trace of a dusky lateral band. The fish reaches the length of 5½ inches.

The long nosed dace or Niagara gudgeon is found in New England and the Middle states, and in the Great lakes region in clear, cold water. In Pennsylvania, according to Cope, it is limited to the rapids and swift waters of the eastern part of the state.

Evermann and Bean collected 50 specimens in Saranac river, Plattsburg N. Y. July 28, 1894, but did not find it in the St Lawrence river or in the Lake Ontario tributaries. Though Dr Meek obtained no specimens of this species from Cayuga lake basin, he believes it a member of the fauna, as it is common in the streams south of Ithaca near Van Ettenville, Chemung co. N. Y.

The long nosed dace frequents rapids and rocky pools, and is associated in mountain regions with the brook trout. Its movements are swift and powerful and it is a very shapely little fish. As a bait for the black bass it is scarcely surpassed.

93 Rhinichthys atronasus (Mitchill)

Black Nosed Dace; Brook Minnow

Cyprinus atronasus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 460, 1815. (Wallkill River; Fresh-water trout brooks of New York); Amer. Month. Mag. I, 289, Aug. 1817. Mud-fish, from Wallkill Creek.

Cyprinus vittatus RAFINESQUE, Amer. Month. Mag. II, 121, Dec. 1817. Hudson River above the falls.

Leuciscus atronasus DE KAY, N. Y. Fauna, Fishes, 205, pl. 23, fig. 69, 1842.

Rhinichthys atronasus GÜNTHER, Cat. Fish. Brit. Mus. VII, 191, 1868; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 208, 1883; MEEK, Ann. N. Y. Acad. Sci. 308, 1888; BEAN, Fishes Penna. 47, pl. 23, fig. 39, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 307, 1896.

Argyreus atronasus STORER, Hist. Fish. Mass. 122, pl. XXI, fig. 4, 1867.

The black nosed dace has a moderately long and stout body, with a broad back, and rather small conical head. The greatest depth of the body is contained four and one fourth to four and one half times in the total length without caudal. The least depth of the caudal peduncle equals one half greatest depth of body. The head is one fourth as long as the fish to caudal base; its width is about one half its length and the snout nearly one third to two sevenths. The eye is as long as the snout and much less than width of interorbital space. The mouth is small,

slightly oblique and with nearly equal jaws; the maxillary barbel small or wanting; the maxilla reaches to below the front edge of the posterior nostril. The dorsal origin is nearer to root of caudal than to tip of snout, over the 26th scale of the lateral line. The length of the base is contained two and one third times in that of the head, and the longest ray equals length of head without snout. The ventral origin is slightly in advance of the dorsal origin, and the fin extends to the vent. The pectoral reaches to the 16th scale of the lateral line. In breeding males it is greatly thickened. The anal origin is behind the end of the dorsal base, under the 34th scale of the lateral line; the fin is variable in length with sex and age, sometimes five sixths as long as the head. The caudal is small and not deeply forked. The lateral line curves downward over the pectoral, soon becoming median. D. ii, 6 or 7; A. ii, 6; V. 8; P. 11. Scales 10–56 to 63–10; teeth 2, 4–4, 2, three of the principal row strongly hooked. Length of the specimens described (no. 33984, U. S. National Museum) 2⅝ to 3 inches. In spirits the upper parts are brown and are separated from the silvery lower parts by a dark lateral band, as wide as the short diameter of the eye and continued on the snout. Breeding males in spring have the lateral band and the lower fins crimson, running into orange in summer. In the young the dark median band extends on the tail fin.

The black nosed dace or "rockfish" is represented in our waters by two forms, one of which is found in the eastern part of the Great lakes region and from Maine to Virginia; this is replaced in the upper lake region and in the Ohio valley, southward to Georgia and Alabama, by the blunt nosed variety, **Rhinichthys obtusus** of Agassiz.

The species grows to the length of 3 inches.

The collections of the U. S. Fish Commission in the Lake Ontario region contained this species from a great many localities: Cape Vincent, Great Sodus bay, Sacketts Harbor, Stony Island, Grenadier island, Oswego, Buena Vista, Belleville, Pulaski, Wart creek, Huntingtonville, Henderson bay, and Webster. The

fish were taken in June, July and August and were rather common in most places.

Evermann and Bean took one example in the St Lawrence river, 3 miles below Ogdensburg, July 17, 1894; they secured eight specimens in the Saranac, at Plattsburg, July 28, 1894. According to Dr Meek it is common near Ithaca in all streams above and below the falls; but was not found by him near Montezuma. Mitchill described the fish from fresh-water brooks of New York containing trout, chiefly from the Wallkill, where Rafinesque also knew of its occurrence. De Kay states its habitat to be clear, fresh-water streams and rivulets of New York and adjoining states. Eugene Smith found it associated with darters, blobs and small minnows in the vicinity of New York city.

This fish prefers clear small brooks. Swift and active in its movements and beautiful in colors, it is one of the most interesting inhabitants of the waters in which it lives. In the aquarium Eugene Smith observed it to eat voraciously of animal food and to be more hardy than any other minnow.

Genus HYBOPSIS Agassiz

Body robust, or variously elongate; mouth terminal or inferior, with lips thin or somewhat fleshy, a conspicuous barbel always present and terminal on the maxillary; a second barbel sometimes present on each side; premaxillaries protractile. Teeth 4-4, or 1, 4-4, 1, or 0; hooked, the grinding surface narrow or obsolete. Scales usually rather large; lateral line continuous. Dorsal inserted over, in front of, or slightly behind ventrals; anal basis short. Males usually with nuptial tubercles, and sometimes flushed with red. A large and varied group, closely allied to Notropis, from which it differs chiefly in the presence of the small maxillary barbel. (After Jordan and Evermann)

Subgenus ERIMYSTAX Jordan

94 Hybopsis dissimilis (Kirtland)

Spotted Shiner.

Luxilus dissimilis KIRTLAND, Bost. Jour. Nat. Hist. III, 341, pl. IV, fig. 2, 1841.

Ceratichthys dissimilis COPE, Cypr. Penna. 368, pl. 12, fig. 1, 1866; GÜNTHER, Cat. Fish. Brit. Mus. VII, 177, 1868; JORDAN & GILBERT, Bull, 16, U. S. Nat. Mus. 215, 1883.

Hybopsis dissimilis JORDAN, Cat. Fish. N. A. 29, 1885; BEAN, Fishes Penna. 48, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 318, 1896.

The spotted shiner has a long and slender body, its greatest depth being nearly one fifth of the total length without the caudal. The caudal peduncle is long and low, its least depth two fifths of greatest depth of body. The width of the body equals two thirds of its depth. The head is moderately large, its length one fourth of the total without the caudal. The snout is long but obtusely rounded at the point, its length one and one half times the diameter of the eye, which is two sevenths of the length of the head. The mouth is small, inferior, horizontal, the maxilla reaching to below the anterior nostril and with a small barbel at its hind end. The gill openings are separated by a very broad isthmus. The dorsal begins over the 16th scale of the lateral line and slightly in advance of the ventral; the dorsal base is one half as long as the head; the longest ray is as long as the head without the snout; the last ray is as long as the snout. The ventral reaches to the vent, its length one seventh of the total without the caudal. The pectoral reaches to below the 13th scale of the lateral line. The anal origin is under the 27th scale of the lateral line; the anal base is short, equaling the diameter of the eye; the longest ray is as long as the ventral; the last ray is one third as long as the head. The caudal is moderately large and deeply forked, the middle rays one half as long as the external rays. The lateral line is nearly straight and median. D. ii, 8; A. ii, 6; V. 7; P. 15. Scales 6–43–5; teeth 4–4, hooked and with a short grinding surface. In spirits the back is brown, the lower parts are whitish, and the sides are broadly striped with silvery. In

life the lateral stripe is bluish and overlaid with dusky spots and is continued forward through the eye around the snout. The fins are pale. The specimen described, no. 36746, U. S. National Museum, from White River Ind., is 3½ inches long.

The spotted shiner occurs in the Great lakes region and Ohio valley southward to Kentucky and west to Iowa. It is abundant in creeks of western Pennsylvania. Kirtland had the species from the Mahoning river and from Lake Erie. The species is most common in the Great lakes and in the channels of large streams, and does not run into small brooks. It is a ready biter and is caught in large numbers by hook fishing. It is useful as bait, being employed with minnows to bait the hooks on "set lines."

The species grows to the length of 6 inches, and derives its name from the bluish band along the sides which is interrupted so as to form spots. The sides are bright silvery in color and the fins unspotted. The body is long and slender.

Subgenus HYBOPSIS Agassiz

95 Hybopsis storerianus (Kirtland)

Lake Minnow

Rutilus storerianus KIRTLAND, Proc. Bost. Soc. Nat. Hist. I, 71, 1842. (Lake Erie)

Leuciscus storerianus KIRTLAND, Bost. Jour. Nat. Hist. V, 30, pl. 9, fig. 2, 1847; GÜNTHER, Cat. Fish. Brit. Mus. VII, 250, 1868.

Ceratichthys lucens JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 213, 1883.

Cliola storeriana JORDAN & GILBERT, op. cit. 171, 1883.

Hybopsis storerianus JORDAN, Cat. Fish. N. A. 28, 1885; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 321, 1896.

Body elongate, compressed, the dorsal outline ascending gradually to origin of dorsal, thence descending to the caudal fin; head short, compressed, its length four and one third in total without caudal; depth of body one fourth total; eye equal to snout, one third length of head; interorbital space broad, flat, somewhat grooved, its width about equal to eye; preorbital bone large, oblong, conspicuous, silvery; mouth rather small, horizontal, the lower jaw included; edge of premaxillary below level of eye; maxillary not reaching to front of orbit; barbel

conspicuous; snout boldly and abruptly decurved, the tip thickened, forming a sort of pad; lateral line somewhat decurved. Rows of scales along back converging behind dorsal, where the upper series run out, as in Notropis cornutus. Fins rather higher and more falcate than in H. kentuckiensis; dorsal fin inserted well forward, over ventrals; pectoral fins pointed, not reaching ventrals; ventrals not reaching vent; caudal long, deeply forked. Teeth usually 1, 4-4, 0, hooked, without grinding surface. Translucent greenish above; sides and below brilliantly silvery; cheeks and opercles with a bright silvery luster; fins plain; a slight plumbeous lateral shade; no caudal spot; no red. Length 5 to 10 inches. Lake Erie to Nebraska and eastern Wyoming, Tennessee, and Arkansas; abundant in the larger streams, specially in Iowa. (After Jordan and Evermann)

Kirtland found the lake minnow only in Lake Erie, where it was frequently taken with seines in fishing for other species. The U. S. Fish Commission recently added it to the fauna of the Lake Ontario basin, three specimens having been collected in Long pond, Charlotte, Aug. 17, 1894.

Subgenus NOCOMIS Girard

96 Hybopsis kentuckiensis (Rafinesque)

Horned Chub; River Chub

Luxilus kentuckiensis RAFINESQUE, Ichth. Ohien. 48, 1820.

Semotilus biguttatus KIRTLAND, Bost. Jour. Nat. Hist. III, 344, pl. V, fig. 1, 1841.

Leuciscus biguttatus DE KAY, N. Y. Fauna, Fishes, 214 (extralimital), 1842.

Ceratichthys biguttatus COPE, Cypr. Penna. 366, pl. 11, fig. 5, 1866; GÜNTHER, Cat. Fish. Brit. Mus. VII, 178, 1868; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 212, 1883.

Ceratichthys micropogon JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 212, 1883.

Hybopsis kentuckiensis BEAN, Fishes Penna. 49, pl. 24, fig. 40, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 322, 1896.

Body stout and rather short, its greatest depth nearly equal to length of head and one fourth of total length without caudal; snout long and obtuse, its length rather more than one third

length of head, and nearly twice diameter of eye; mouth large and placed low, the maxilla reaching to below front of eye, the lower jaw shorter than upper; dorsal origin slightly nearer to root of caudal than to tip of snout, its base one half as long as the head and two thirds as long as its longest ray; ventral under front part of dorsal, its length equal to dorsal base; anal origin under 24th scale of lateral line, longest anal ray about one seventh of total to caudal base, pectoral two thirds as long as head, and reaching to below 13th scale of lateral line; caudal moderately forked. D. iii, 7; A. iii, 6. Scales 6-40 to 45–5. Color bluish olive, the head darker; green and coppery reflections on the sides. Fins pale orange, pinkish in spring; lower parts white. Breeding males have the top of head swollen into a crest and covered with coarse tubercles, from which arises the name horned chub; they have also sometimes a red spot on each side of head. The young have a broad dark median band and a dusky spot at the base of the tail fin.

Rafinesque states that the fish is known as Indian chub, redtail and shiner. Other names in eastern localities are nigger chub, river chub, jerker, horned dace and horny-head.

The species ranges from Pennsylvania westward to Dakota and south to Alabama. In Pennsylvania it is common in the Susquehanna and the Ohio basin, but absent from the Delaware. Dr Meek collected a few specimens at Montezuma N. Y. and found none in any of the other localities investigated. Eugene Smith refers to this species two specimens of fish from the Passaic river. The flesh of his fish appeared to be very soft.

The horned chub abounds in large rivers and is rarely seen in small brooks. This minnow grows to a length of 10 inches and is good for food. As a bait for the black bass the young horned chub, because of its endurance on a hook, can not be excelled.

Genus COUESIUS Jordan

Body elongate; head normal, not depressed, the profile convex; mouth terminal, normal, a well developed barbel on the anterior side of maxillary, just above its tip. Teeth 2, 4 4, 2,

hooked, without grinding surface. Scales rather small; lateral line continuous. Dorsal fin over or slightly behind ventrals; anal basis short. Size rather large. This genus is closely related to the section Nocomis under Hybopsis, from which it may be separated by the presence of two teeth in the lesser row, by the position of the barbel, and by the smaller scales. Its relations with Semotilus are equally close. The species are not well known. (After Jordan)

97 Couesius plumbeus (Agassiz)

Lake Chub; Plumbeous Minnow; Horse Lake Minnow

Gobio plumbeus Agassiz, Lake Superior, 366, 1850.
Ceratichthys prosthemius Cope, Cypr. Penna. 365, pl. XI, fig. 4, 1866.
Ceratichthys plumbeus Günther, Cat. Fish. Brit. Mus. VII, 176, 1868.
Couesius dissimilis Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 218, 1883, in part.
Couesius prosthemius Jordan & Gilbert, op. cit. 219, 1883; Mather, App. 12th Rep. Adirondack Surv. 30, 1886.
Couesius plumbeus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 323, 1896.

Body moderately elongate and somewhat compressed; greatest depth four and one half to four and two thirds in total length without caudal, and equal to length of head; head rather flat above, not much raised above the level of the eyes; interorbital space nearly one and one half times long diameter of eye, which equals snout and is one fourth length of head; head four and one third in total without caudal; maxillary reaching to below front of orbit, a small barbel placed high at its tip, lower jaw well included. Scales small, smaller in advance of dorsal fin. Lateral line beginning high up on the nape, abruptly descending to the median line over the pectoral fin, and thence running nearly straight to the caudal fin. Dorsal origin midway between tip of snout and base of caudal fin, over middle of ventral base, longest ray two thirds of head, length of base one half of head; ventral scarcely longer than dorsal base, the fin not reaching vent; longest anal ray equal to ventral, base of anal two fifths of head; pectoral reaching to 18th scale of lateral line; caudal deeply forked, its upper lobe two ninths of total without caudal. D. 8; A. 8. Scales 13–65–8; teeth 2, 4–4,

2. Brown above; sides somewhat silvery, abruptly separated from the dusky upper parts; snout and top of head back as far as hind border of eye, dusky; fins plain. Length 7 inches. Streams and lakes from Lake Superior east to the Adirondack region and Canada; more common northward. Here described from specimens from Beaver river, Herkimer co. N. Y., and Lake Lomond, near St John N. B.

Mather had specimens from Morse lake, in the Adirondacks, and it is reported also from Seventh lake, Fulton Chain. The species is known from Lake Superior east to the Adirondacks and New Brunswick. Agassiz had it from Lake Huron as well as Lake Superior.

Genus EXOGLOSSUM Rafinesque

Body rather short and stout, subterete; lower jaw three-lobed, the dentary bones being close together and completely united, not forming a wide arch as in the minnows generally; upper jaw not protractile; pharyngeal bones small, the teeth hooked, and without grinding surface, 1, 4-4, 1. Scales moderate; lateral line complete. Dorsal origin is nearly over the beginning of the ventral; anal fin short; isthmus broad; gill rakers weak; pseudobranchiae present; air bladder normal; alimentary canal short; peritoneum white. Size large. No marked sexual peculiarities; the males with some black pigment in spring.

98 Exoglossum maxillingua (Le Sueur)

Cut-lips; Nigger Chub

Cyprinus maxillingua LE SUEUR, Jour. Ac. Nat. Sci. Phila. I, 85, 1817, Pipe Creek, Maryland.

Exoglossum annulatum RAFINESQUE, Jour. Ac. Nat. Sci. Phila. I, 421, 1818, Hudson River.

Exoglossum nigrescens RAFINESQUE, op. cit. I, 421, 1818. Lake Champlain.

Exoglossum rittatum RAFINESQUE, op. cit. I, 421, 1818. Hudson River.

Exoglossum maxillingua AGASSIZ, Amer. Jour. Sci. Arts, XIX, 215, 1855; COPE, Cypr. Penna. 360, pl. XI, fig. 1, 1866; GÜNTHER, Cat. Fish. Brit. Mus. VII, 188, 1868; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 160, 1883; BEAN, Fishes Penna. 36, pl. 22, fig. 36, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 327, 1896, pl. LIV, fig. 140, head below.

The cut-lips has a stout, short and thick body, its greatest hight nearly equal to the length of the head, and one fourth of

the total without caudal. The caudal peduncle is short and deep, its least depth about one half the head. The snout is short and obtusely conical, its length somewhat greater than the eye and nearly equal to one third of the head. The maxilla reaches to below the nostrils, its length equaling that of the snout. Head four and one fifth in total to base of caudal. The dorsal origin is nearly over the ventral origin and in the vertical through the 23d scale of the lateral line. The dorsal base is about one half as long as the head, and its longest ray equals twice the distance from the dorsal origin to middle of eye. The pectoral is about as long as the longest dorsal ray, and the ventral reaches to the anal origin. The base of the anal is one half as long as the longest anal ray. The caudal is moderately forked. D. 8; A. 7. Scales 9–54 6; teeth 1, 4–4, 1. Length of specimen described, $4\frac{3}{4}$ inches; from Takoma Park D. C. Color brown or olivaceous, darker above; a short and narrow dark bar above root of pectoral; young with a dusky bar at the caudal base. Fins dusky, their extremities pale.

The cut-lips may be readily distinguished by the three-lobed lower jaw, the dentary bones being closely united and the lower lip represented by a fleshy lobe on each side of the mandible.

The cut-lips is known also as chub, butter chub, nigger chub, and day chub. It is a very common species in the Susquehanna and its tributaries. Its range is not extensive, reaching only from western New York to Virginia. In New York it occurs in Lake Ontario, the St Lawrence, Lake Champlain, Cayuga lake, and the Hudson river. The U. S. Fish Commission has it from the following New York localities in the Lake Ontario basin:

Mouth Salmon river, Selkirk.
Big Sandy creek, Belleville.
Wart creek, Buena Vista.
Little Stony brook, Henderson bay.
Big Stony creek, Henderson Harbor.
Spring brook, Pulaski.
Black river, Huntingtonville.

All of these were obtained in July, 1894. Evermann and Bean collected it also in the St Lawrence, 3 miles below Ogdensburg,

July 17, 1894, and in Scioto creek, Coopersville and Saranac river, Plattsburg, July 19, 1894.

Dr Meek found it in small numbers in Six Mile creek and Fall creek below the falls. It inhabits clear running water.

The fish grows to the length of 6 inches and may be at once distinguished from all of the other minnows by its three-lobed lower jaw. It is believed that this singular structure of the mouth enables the fish to scrape mollusks from their hold on rocks, as its stomach usually contains small shellfish. It takes the hook readily.

Genus CARASSIUS Nilsson

This genus differs from Cyprinus in being without barbels; its pharyngeal teeth are compressed, in a single series, 4–4.

Temperate Asia and Europe. Domesticated and degenerated into numerous varieties. (After Günther)

Pharyngeal teeth spatulate, four in a row on each side; mouth terminal, without barbels; base of the dorsal fin elongate; anal fin short; both fins with a spine which is serrated behind. (After Heckel and Kner)

Body oblong, compressed and elevated; mouth terminal, without barbels; teeth 4–4, molar, but compressed; scales large; lateral line continuous; dorsal fin very long, with the third ray developed into a stout spine, which is serrated behind; anal short with a similar spine; ventrals well forward. (After Nilsson)

99 Carassius auratus (Linnaeus)

Goldfish (Introduced)

Cyprinus auratus LINNAEUS, Syst. Nat. ed. X, I, 322, 1758; CUVIER & VALENCIENNES, Hist. Nat. Poiss. XVI, 101, 1842; DE KAY, N. Y. Fauna, Fishes, 190, 1842; STORER, Hist. Fish. Mass. 115, pl. XXI, fig. 1, 1867.

Carassius auratus BLEEKER, Syst. Cypr. rev. Ned. Tijdschr. Dierk. I, 255, 1863; Atlas Ichth. Cypr. 74, 1863; GÜNTHER, Cat. Fish. Brit. Mus. VII, 32, 1868; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 253, 1883; GOODE, Fish & Fish. Ind. U. S. I, pl. 231, 1884; BEAN, Fishes Penna. 54, pl. 25, fig. 43, 1893; JORDAN & EVERMANN, Check List Fish. N. A. 512, 1896.

The body of the goldfish is oblong, stout, with the back elevated and compressed. Its depth at dorsal origin is contained

about two and one half times in the total length without the tail; the head is contained three and one third times in this length. The head is small in front of eye, being depressed on snout, and the dorsal profile from tip of snout to dorsal fin is very steep. The rather small eye equals one fifth or less of length of head. Mouth terminal, oblique, rather small, the maxilla not reaching the vertical from front of eye. No barbels. Teeth compressed, 4–4. The dorsal fin is high and long, commencing over the seventh scale of the lateral line and running back to near the caudal; its longest rays, first and second, a little longer than the spine, equal to one half of depth of body, or length of head from pupil to its posterior end. From the third to the last the rays gradually decrease in size, the last being less than half the length of the longest. The first dorsal spine is minute, one fourth the length of second, which is strong and coarsely serrated. The anal is short, the length of its base being but two thirds the length of its longest rays; first spine small, one third the length of second, which is stout and serrated. Pectoral fin broad and rounded, its length three fifths of that of head, or equal to longest anal ray. It reaches to ventral, which is placed well forward. Caudal fin large; scales large, deeper than long; lateral line median, complete, almost straight. D. II, 18; A. II, 7; V. 9. Scales 5-30-6. The specimen described is from the fish ponds, at Washington D. C. Length 8 inches.

The common goldfish or silverfish is a native of Asia, whence it was introduced into Europe and from there into America, where it is now one of the commonest aquarium fishes and is extremely abundant in many of our streams. In Pennsylvania it abounds in the Delaware and Schuylkill river.

De Kay made the following remarks about the goldfish, or golden carp, as he styles it.

The golden carp, or goldfish, as it is more generally called, was introduced from China into Europe in the early part of the 17th century, and probably shortly after found its way to this country. They breed freely in ponds in this and the adjoining states. They are of no use as an article of food, but are kept

in glass vases as an ornament to the parlor and drawing room. They are said to display an attachment to their owners, and a limited obedience to their commands.

They are introduced into lakes, ponds, fountains and reservoirs generally. An individual was kept in a fountain at 42d street and 5th avenue, New York, by Patrick Walsh nine years, and was then presented to the aquarium.

At the Cold Spring Harbor hatchery, L. I., several varieties were hatched from the same lot of eggs. These included the normal form, the typical fantail, and one which was so deep-bodied that it could scarcely balance itself in swimming.

The goldfish in the New York aquarium were never troubled by fungus or parasites.

In many of our streams and ponds, the goldfish has run wild, and hundreds of the olivaceous type will be secured to one of a red color. In the fauna of the moraine ponds and in quarry holes, the goldfish stands first. It will breed in foul water where only catfish and dogfish [U m b r a] can be found. *Eugene Smith*

The goldfish is extremely variable in color and form. It is usually orange, or mottled with black and orange, yet in some streams, and even in pond culture, silvery individuals are often more common than any of the mottled varieties. The species grows to the length of 12 inches. It spawns early in the spring and is subject to many dangers and is attacked by numerous enemies. The fish, however, is extremely hardy, prolific, and tenacious of life.

Genus CYPRINUS Linnaeus

Body robust, compressed, resembling that of the buffalo fish; mouth moderate, anterior, with four long barbels; snout blunt, rounded; teeth molar, broad and truncate, 1, 1, 3-3, 1, 1; scales large; lateral line continuous; dorsal fin very long, with a stout spine, serrated behind; anal fin short, also with a spine. Large fishes of the fresh waters of Asia; introduced into Europe and America as food fishes. It has been generally introduced into private ponds in nearly all parts of the United States; from these it has escaped into the streams and lakes, and is now an

abundant fish in most of our larger, warmer rivers and in the ponds and bayous of the Mississippi valley. On the south shore of Lake Erie (and in the Mississippi near Quincy Ill. and the Delaware river) it has become well established and is of considerable commercial importance. (After Jordan and Evermann)

100 Cyprinus carpio Linnaeus

Carp (Introduced)

Cyprinus carpio Linnaeus, Syst. Nat. ed. X, I, 320, 1758; Cuvier & Valenciennes, Hist. Nat. Poiss. XVI, 23, 1842; De Kay, N. Y. Fauna, Fishes, 188, 1842; Heckel & Kner, Süssw. Fische, 54, fig. 21, 1858; Günther, Cat. Fish. Brit. Mus. VII, 25, 1868; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 254, 1883; Goode, Fish. & Fish. U. S. I, pl. 230, Leather carp, 1884; American Fishes, 411, figure, 1888; Bean, Fishes Penna. 55, pl. 1, colored, 1893; Jordan & Evermann, Check-List Fishes N. A. 512, 1896.

The carp has a stout and moderately elongate body and a small head. The greatest depth equals one third of the length without the caudal fin. The length of the head is nearly one fourth of the total to the base of the tail. The caudal peduncle is about two fifths as deep as the body, and the caudal fin is strongly forked. The eye diameter is contained six and one half times in the length of the head. The mouth is moderate, the upper jaw not extending to front of eye. The dorsal begins at a distance from tip of snout equal to twice length of head; the length of its base equals twice length of pectoral; the longest ray equals length of head without the snout; the last ray is two fifths as long as the head. The anal begins under the 15th ray of the dorsal; its longest ray is two thirds as long as the head and more than twice as long as the last ray; the length of its base is about two fifths of length of head. The ventral begins under the second ray of the dorsal; its length nearly equals longest dorsal ray. The pectoral is nearly one fifth of total length without the caudal. The long spines of the dorsal and anal are strongly serrate along their hinder edges. A barbel on the upper lip and another at the angle of the mouth on each side; the longest barbel about equal to diameter of eye. Three varieties are recognized, the scale, the mirror and the

leather carp, based chiefly on the scaling of the body. The leather carp is nearly naked, and is said to be the best variety; the mirror carp has a few large scales irregularly placed; and the scale variety has the body completely scaled. The color is olivaceous, varying into dusky and blue. In the leather carp the lower parts are more or less suffused with yellowish. D. III, 20; A. III, 5; V. I, 7; P. 15. Scales 5–38–5.

The carp is a native of Asia and has been introduced into Europe and America as a food fish, chiefly for pond culture. It thrives in all warm and temperate parts of the United States and reaches its best condition in open waters. In Texas it has grown to a length of 23 inches in 11 months after planting. The leather variety is most hardy for transportation. Mr Hessel has taken the carp in the Black and Caspian seas; salt water seems not to be objectionable to it, and it will live in stagnant pools, though its flesh will be decidedly inferior in such waters. The carp hibernates in winter except in warm latitudes, takes no food and does not grow; its increase in size in temperate latitudes occurs only from May to August.

Reproduction. The spawning season begins in May and continues in some localities till August. A carp weighing 4 to 5 pounds, according to Mr Hessel, yields from 100,000 to 500,000 eggs; the scale carp contains rather more than the other varieties. During the spawning the fish frequently rise to the surface, the female accompanied by two or three males. The female drops the eggs at intervals during a period of some days or weeks in shallow water on aquatic plants. The eggs adhere in lumps to plants, twigs and stones. The hatching period varies from 12 to 16 days.

Size. According to Hessel the average weight of a carp at three years is from 3 to 3½ pounds; with abundance of food it will increase more rapidly in weight. The carp continues to add to its circumference till its 35th year, and in the southern parts of Europe Mr Hessel has seen individuals weighing 40 pounds and measuring 3½ feet in length and 2¾ feet in circumference. A carp weighing 67 pounds and with scales 2½ inches

in diameter was killed in the Danube in 1853. There is a record of a giant specimen of 90 pounds from Lake Zug in Switzerland. Examples weighing 24 pounds have been caught recently in the Potomac river at Washington D. C.

Food. The carp lives principally on vegetable food, preferably the seeds of water plants such as the water lilies, wild rice and water oats. It will eat lettuce, cabbage, soaked barley, wheat, rice, corn, insects and their larvae, worms and meats of various kinds. It can readily be caught with dough, grains of barley or wheat, worms, maggots, wasp larvae, and sometimes with pieces of beef or fish.

During the summer of 1897 two female leather carp died in captivity as a result of retention of the eggs.

Large individuals are found in Prospect park lake, Brooklyn, where the species was introduced. The food of the fish in captivity includes hard clam, earthworms, wheat, corn, lettuce and cabbage. Its growth is remarkable. A leather carp has fully doubled its weight in one year.

Linnaeus says the carp was introduced into England about the year 1600. De Kay places the first introduction into New York waters in the year 1831 and publishes a letter of Henry Robinson, Newburg, Orange co., who brought them from France, reared and bred them successfully in his ponds, and planted from one dozen to two dozen annually in the Hudson during the four years preceding his letter. Mr Robinson stated that they increased greatly and were frequently taken by fishermen in their nets.

Order APODES

Eels

Suborder ENCHELYCEPHALI

Family ANGUILLIDAE

True Eels

Genus ANGUILLA Shaw

Body elongate, subterete, compressed posteriorly, covered with small, linear, embedded scales which are placed obliquely, some of them at right angles to others; lateral line well devel-

oped; head long, conical, pointed; eye small, well forward, over the angle of the mouth; teeth small, villiform, subequal, in bands on each jaw and a long patch on the vomer; tongue free at tip; lips rather full, with a free margin behind, attached by a frenum in front; lower jaw projecting; gill openings rather small, slit like, about as wide as base of pectorals and partly below them; nostrils superior, well separated, the anterior with a slight tube; vent close in front of anal; dorsal inserted at some distance from the head, confluent with the anal around the tail; pectorals well developed. Species found in most warm seas (the eastern Pacific excepted) ascending streams, but mostly spawning in the sea. (After Jordan and Evermann)

101 Anguilla chrysypa Rafinesque

Eel

Anguilla chrysypa Rafinesque, Amer. Month. Mag. II, 120, Dec. 1817. Lake George; Lake Champlain; Hudson River above the falls.

Anguilla vulgaris Mitchill, Trans. Lit. and Phil. Soc. N. Y. I, 330, 1815; Goode, Fish & Fish. Ind. U. S. I, pl. 239, 1884.

Muraena bostoniensis Le Sueur, Jour. Ac. Nat. Sci. Phila. 81, 1821.

Anguilla tenuis Girard, Ichth. U. S. Mex. Bdy. Surv. 75, pl. 40, 1859.

Anguilla blephura Rafinesque, Amer. Month. Mag. II, 120, Dec. 1817. South shores of Long Island.

Muraena rostrata Le Sueur, Jour. Ac. Nat. Sci. Phila. 81, 1821. Cayuga Lake.

Anguilla tenuirostris De Kay, N. Y. Fauna, Fishes, 310, pl. 73, fig. 173, 1842.

Anguilla rostrata De Kay, op. cit. 312, 1842. Copied from Le Sueur. Lakes Cayuga and Geneva, N. Y.; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 361, 1883; Bean, Fishes Penna. 95, pl. 30, fig. 58, 1893.

Anguilla macrocephala De Kay, op. cit. 313, 1842. After Le Sueur. Saratoga Lake, N. Y.

Anguilla bostoniensis Storer, Hist. Fish. Mass. 214, pl. XXXIII, fig. 1, 1867.

Anguilla chrysypa Jordan & Davis, Rev. Apod. Fish. 668, 1892; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 348, 1896, pl. LV, fig. 143.

In the eel the body is elongated, roundish throughout most of its extent, compressed behind. The scales are deeply embedded and very irregularly placed, some at right angles to others. The head is conical, elongated with pointed snout and small eye, except in the male. The lower jaw is longer than the upper. The jaws with small teeth in bands; a long patch of teeth on the vomer. The gill openings are partly below the

pectoral fins, small and slitlike. The beginning of the dorsal is at a distance of nearly twice the length of the head behind the gill opening. The anal begins still farther back, and the vent is close to its origin. The dorsal and anal fins are continuous around the tail. Hight of body nearly two thirds the length of the head, which is contained about eight and one fourth times in the total. The distance from the gill opening to the vent equals two and one half times the length of the head. The color varies greatly, but is usually dark brown, more or less tinged with yellow; lower parts paler. In the male referred to the upper parts were silvery gray sharply separated from the satiny white of the abdomen. In the eel the lateral line is very distinct.

The eel appears to have only one common name. It is one of the best known and most singular of our fishes, yet its breeding habits are even now enveloped in doubt. The species ascends the rivers of eastern North America from the Gulf of St Lawrence to Mexico, the former being the northern limit of the species on our coast. In the Ohio and Mississippi valleys it is extremely common, and its range has been much extended by the opening of canals and by artificial introduction. It has been transferred to the Pacific coast.

The eel has been known to exceed a length of 4 feet. The average length of individuals however is about 2 feet. The female is larger than the male, paler in color, and is different in certain other particulars, which will be mentioned in the description of the species.

This is a very important food fish. It is caught chiefly when descending the rivers in the fall. In 1869 about a ton of eels were caught in a single fish basket above Harrisburg. At the present time this method of capture is illegal. Both adults and young eels ascend the streams in spring, the young coming in millions, but in the fall run small eels are seldom seen. Till a comparatively recent date it was not certainly known that the eels have eggs which are developed outside of the body. Even now the breeding

habits are unknown, but it is supposed that spawning takes place late in the fall or during the winter near the mouths of rivers on muddy bottoms. Dr Jordan has expressed the belief that the eel sometimes breeds in fresh water, since he has found young eels less than an inch long in the headwaters of the Alabama river, about 500 miles from the sea. It is estimated that a large eel contains about 9,000,000 eggs. The eggs are very small, measuring about 80 to the inch, and can scarcely be seen by the naked eye.

The difference of size in the sexes has already been referred to. According to one writer the males are much smaller than the females, rarely exceeding 15 or 16 inches in length. The question whether eels will breed in fresh water has an important bearing on their introduction into places from which they can not reach the sea. The generally accepted belief is that, while the eels will grow large and fat, they will not reproduce under such circumstances.

When the eels meet obstructions in streams, they will leave the water and travel through wet grass or over moist rocks. They have not been able to surmount the falls of Niagara. At the foot of this barrier hundreds of wagon loads of young eels have been seen crawling over the rocks in their efforts to reach the upper waters.

Dr Mitchill heard of an eel, which was caught in one of the south bays of Long Island, that weighed 16½ pounds. He records the use of eelpots and the practice of bobbing, and also the winter fishing by spearing. Dr Mitchill states distinctly that the ovaries of eels may be seen like those of other fish, but they are often mistaken for masses of fat. Dr DeKay states that he had examined the silver eel of the fishermen and was disposed to consider it only a variety of the common eel. He characterizes it as "silvery gray above, with a clear, satiny white abdomen, separated from the color above by the lateral line." We found eels moderately common in Great South bay late in September. At Bellport thousands of eelpots are employed, and these are fastened to stakes which are set in straight lines

over a large extent of the bottom. These stakes project from four to six feet above the surface of the water. At Blue Point cove, Great River beach and Fire Island we found five individuals of a kind of eel known to the fishermen as silver eel. These were taken between September 25 and October 7, and they were the only ones of the kind seen by us. They attracted attention at once, both on account of their colors, large eyes, short snouts and long pectoral fins, as compared with the common form. There is still some doubt in my mind as to whether this represents a distinct species or not. It may be the silver eel, Anguilla argentea, of Le Sueur, which is described as silvery gray above, separated from the silvery white abdomen by a distinct lateral line. But, to whatever species they may be referred, the greatest interest attaches to them because they have proved, on examination by Prof. John A. Ryder, to be males with the generative glands so well developed as to leave no doubt concerning the sex of the individuals. Prof. Ryder has published a report on these specimens, with figures showing sections of the syrskian organs, and announces the fact that the male eel has now been positively indentified from at least two points along our eastern coast, the other locality being Woods Hole Mass. He felt little doubt that, if the eels had been taken a few weeks later, ripe spermatozoa would have been found in them, and he considers it probable that the eggs are cast some time during the months of December or January. The specimens from Woods Hole were taken in November 1881, and they show slightly larger syrskian organs than in the Fire island specimens.

In captivity eels live many years. They delight to lie buried in the mud or sand with only their heads out, ready for anything edible to come within reach. Mussels and snails are picked out of the shells by them. (After Eugene Smith[1])

The eel in captivity is particularly liable to attacks of fungus, which do not always yield to treatment with salt or brackish

[1] Linn. Soc. N. Y. Proc. 1897. no. 9, p. 29.

water; but the parasite can be overcome by placing the eel in a poorly lighted tank.

In Cayuga lake, N. Y., according to Dr Meek, the eel is not common, but is occasionally taken at each end of the lake.

W. H. Ballou makes the following remarks about their feeding habits:

They are among the most voracious and carnivorous fishes. They eat most inland fishes except the gar and the chub. . . They are particularly fond of game fishes, and show the delicate taste of a connoisseur in their selections from choice trout, bass, pickerel and shad. . . On their hunting excursions they overturn huge and small stones alike, working for hours if necessary, beneath which they find species of shrimp and crayfish, of which they are exceedingly fond. . . They are among the most powerful and rapid of swimmers. . . They attack the spawn of other fishes open-mouthed, and are even said to suck the eggs from an impaled female. . . They are owl-like in their habits, committing their depredations at night.

Family LEPTOCEPHALIDAE

Conger Eels

Genus LEPTOCEPHALUS (Gronow) Scopoli

Body formed as in Anguilla; no scales; head depressed above, anteriorly pointed; lateral line present; mouth wide, its cleft extending at least to below middle of eye; teeth in outer series in each jaw equal and close set, forming a cutting edge, no canines, band of vomerine teeth short, tongue anteriorly free; vertical fins well developed, confluent around the tail, pectoral fins well developed, dorsal beginning close behind pectorals; gill openings rather large, low; eyes well developed; posterior nostril near eye, anterior near tip of snout, with a short tube; lower jaw not projecting. Skeleton differing in numerous respects from that of Anguilla. Vertebrae about 56–100. In most warm seas. This genus contains the well known and widely distributed conger eel and three or four closely related species. (After Jordan and Evermann)

Lateral line in a deep, pale furrow, decurved slightly from the head to below dorsal origin, very conspicuous pores in its anterior third.

102 Leptocephalus conger (Linnaeus)

Conger Eel; Sea Eel

Muraena conger Linnaeus, Syst. Nat. ed. X, I, 245, 1758.
Anguilla conger Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 360, 1815.
Anguilla oceanica Mitchill, Jour. Ac. Nat. Sci. Phila. I, 407, 1818, off New York.
Conger occidentalis De Kay, N. Y. Fauna, Fishes, 314, pl. 53, fig. 172, 1842, very poor.
Conger vulgaris Günther, Cat. Fish. Brit. Mus. VIII, 38, 1870.
Conger niger Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 362, 1883.
Leptocephalus conger Goode, Fish & Fish. Ind. U. S. I, pl. 240, 1884; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 354, 1896, pl. LVII, fig. 148, 1900; Smith, Bull. U. S. F. C. XVII, 90, 1898.

Dorsal fin begins opposite to or just behind tip of pectoral; eye one and one half in snout, five to six in head; snout three and one fourth to four and one fourth in head; gape extending nearly or quite to below hind margin of eye; head one and four fifths to one and six sevenths in trunk; tail longer than rest of body; pectorals three and one half in head; upper lip full, with conspicuous pores. Length of head one ninth of total length, depth of body two fifths length of head. Pores in lateral line very conspicuous. Color dark olive brown, sometimes nearly black, above; chin, space behind pectorals and lower parts soiled white.

The conger eel occurs on both coasts of the Atlantic, on our coast extending from Cape Cod to Brazil, but not often coming into shallow bays. An exception is noted in Great Egg Harbor bay, where the fish is not rare in summer. It is sometimes caught in Gravesend bay also in summer, and occasional individuals are captured on hand lines off Southampton L. I., by men fishing for sea bass and scup. The fishermen dislike to handle the species on account of its pugnacity and strength; it snaps viciously at everything near it when captured in our waters; yet, strangely enough, the writer has seen a hundred or more, taken on trawl lines off the north coast of France, in a boat at one time, and not one gave evidence of ferocity.

In captivity in the aquarium the sea eel suffers severely from fungus attacks, which are not relieved by changing the fish from salt water to fresh. Perhaps the salinity of the water in some

localities is too low, and relief might be obtained by supplying sea water of normal ocean density.

The young and larval form of the conger is a curious, elongate, transparent, bandlike creature with a minute head, a very small mouth and with the lateral line, belly, and anal fin dotted with black points.

An individual nearly 3 feet long was captured with a hand line by A. P. Latto in the ocean, near Southampton L. I. Aug. 3, 1898, while fishing for sea bass and scup.

In the Woods Hole region, according to Dr Smith, "it comes in July and remains until fall; very common for several years, but rather rare formerly. Fishermen as a rule do not distinguish it from the common eel. A few are taken in traps and with lines, but many large ones, weighing from 8 pounds upward, are caught in lobster pots. A specimen in the collection weighs 10 pounds. One caught on a line at Falmouth, Aug. 30, 1897, weighed 12 pounds. The smallest observed are 15 to 20 inches long."

Mitchill declared the flesh to be very dainty eating. DeKay said the flesh has a peculiar unsavory taste. He discovered that it is a vicious animal, snapping when captured at everything near it. In France the conger eel is among the cheapest and least esteemed of the food fishes.

The observations of Dr Otto Hermes, director of the Berlin aquarium, on the habits and the reproduction of the conger eel are of very great interest. Reference is made to them by Goode in *Fish and Fishery Industries of the United States*, § 1, p. 657, and two figures copied from drawings of Dr Hermes are given in the text. The ovary of the conger, says Dr Hermes, is developed in captivity, and this is often the cause of the death of the eel. In a conger which died in the Berlin aquarium the ovaries protruded very extensively, and a specimen in the Frankfort aquarium burst on account of the extraordinary development of the ovaries. The ovaries of this eel, which weighed 22½ pounds, themselves weighed 8 pounds, and the number of eggs was about 3,300,000. The want of a natural opening for the escape of the eggs was evidently in this case, the cause of death. In the fall

of 1879 Dr Hermes received a number of small sea eels taken in the vicinity of Havre. These eels ate greedily and grew rapidly. Only one was tardy in its development, so that it could easily be distinguished from the rest. This one died June 20, 1880, and was examined the same day. It proved to be a sexually mature male and served to clear up some very doubtful problems in the reproduction of the species, as well as its ally, the common eel.

Order ISOSPONDYLI

Isospondylous Fishes

Family ELOPIDAE

Tarpons

Genus TARPON Jordan & Evermann

Body oblong, compressed, covered with very large, thick, silvery, cycloid scales; belly narrow, but not carinated, its edge with ordinary scales; mouth large, oblique, the lower jaw prominent, maxillary broad, extending beyond the eye; villiform teeth on jaws, vomer, palatines, tongue, sphenoid, and pterygoid bones; eye very large, with an adipose eyelid; lateral line nearly straight, its tubes radiating widely over the surface of the scales; branchiostegals 23; pseudobranchiae wanting; gill rakers long and slender; dorsal fin short and high, inserted behind the ventrals (over the ventrals in Megalops), its last ray elongate and filamentous as in Megalops, Dorosoma, and Opisthonema; anal fin much longer than dorsal, falcate, its last ray produced; caudal widely forked; pectorals and ventrals rather long; anal with a sheath of scales; dorsal naked; caudal more or less scaly; a collar of large scales at the nape. Vertebrae about 57 (28+29). Size very large, the largest of the herringlike fishes. (After Jordan and Evermann)

103 Tarpon atlanticus (Cuv. & Val.)

Tarpum; Tarpon; Grande Écaille; Silver King

Megalops atlanticus CUVIER & VALENCIENNES, Hist. Nat. Poiss. XIX, 398, 1846. Guadaloupe.

Megalops elongatus GIRARD, Proc. Ac. Nat. Sci. Phila. 224, 1858, Long Island.

Megalops thrissoides GÜNTHER, Cat. Fish. Brit. Mus. VII, 472, 1868; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 262, 1883; GOODE, Fish & Fish. Ind. U. S. I, 610, pl. 217 B, 1884; American Fishes, 406, fig. 1888.

Tarpon atlanticus JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 409, 1896; pl. LXVII, fig. 177, 1900; SMITH, Bull. U. S. F. C. XVII, 90, 1898; EVERMANN & MARSH, Fishes Porto Rico, Bull. U. S. F. C. 1900; 80, fig. 10, 1900.

Body elongate, compressed, not deep, its greatest hight about one fourth of total length without caudal. Length of head nearly equal to greatest hight of body. Mouth large, oblique, the lower jaw very prominent, the maxillary extending beyond the vertical from hind margin of eye; eye moderately large, two thirds length of snout, two elevenths length of head; dorsal origin midway between tip of snout and end of middle caudal rays, dorsal base two fifths as long as head, dorsal filament nearly as long as the head; ventral origin midway between tip of snout and end of anal fin, the ventral fin two fifths as long as the head; base of anal three fourths as long as the head; pectoral fin as long as the longest ray of dorsal; caudal deeply forked, its longest rays equal to dorsal filament. Size large, weight reaching nearly 200 pounds and length 6 or 7 feet. Color silvery, darker above. D. III, 12; A. III, 23; P. 13; V. II, 9. Scales 12–47.

The tarpon inhabits the western Atlantic from Cape Cod to Brazil and the West Indies, being rather uncommon northward, but abundant toward the south, ascending rivers in pursuit of smaller fishes on which it feeds. The species grows to the length of 7 feet and the weight of 150 pounds, or upward. It is not prized for food, but is now very celebrated as a game fish of great endurance and strength. The scales are an article of commerce as curiosities. Fishermen dread the tarpon because it leaps through their nets with great violence, and the Pensacola seiners have known of persons being killed or severely injured by its leaping against them from the seine in which it was inclosed. As to the edible qualities of the flesh opinions differ, but the fact is that the species is seldom eaten.

Girard had a specimen from Long Island which he described in 1858. Since that time it has been seen there occasionally. In the fall of 1898, Capt. H. E. Swezey reported to me that he found one about 4 feet long in Swan river at Patchogue. The fish was

recently dead, and he believes it came into the river alive. In the vicinity of Woods Hole Mass. it is now a regular summer visitor. According to Dr Smith, it is "taken every year in traps at South Dartmouth, also occasionally at Quissett and at Menemsha, in latter part of September. All are about one size, 80 to 100 pounds. Fishermen call them 'big scale fish.' An effort has been made to find a market for them in New Bedford, but the people did not like them, owing to the toughness of the flesh."

The tarpon evidently breeds at Porto Rico, as Evermann and Marsh collected a number of individuals measuring from 2¼ to 3¼ inches at Fajardo in February 1899, these apparently being the first young of the species so far recorded.

Genus ELOPS Linnaeus

Body elongate, subcylindric; scales small, silvery; head moderate; conical anteriorly, with very long jaws, the lower slightly included; branchiostegals 30; eye large and placed high; dorsal fin high in front, the last rays short, origin of fin about midway between tip of snout and end of middle caudal rays, the fin depressible into a scaly sheath; anal fin short, well behind end of dorsal, also depressible into a sheath; pectorals and ventrals each with a long appendage; caudal fin long and deeply forked; opercular bones thin, with expanded, membranaceous borders, a collar of scales on occiput; lateral line continuous, nearly straight, its tubes simple; large pseudobranchiae. Vertebrae 43+29=72. Large fishes of the open seas. The young are ribbon-shaped, elongate, and pass through a series of metamorphoses similar to the changes observed in the congers.

104 Elops saurus Linnaeus

Big-eyed Herring

Elops saurus LINNAEUS, Syst. Nat. ed. XII, I, 518, 1766; DE KAY, N. Y. Fauna, Fishes, 267, pl. 41, fig. 131, 1842; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 261, 1883; GOODE, Fish & Fish. Ind. U. S. I, 611, pl. 218, upper figure, 1884; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 410, 1896; pl. LXVII, fig. 178, 1900; BEAN, Bull. Amer. Mus. Nat. Hist. IX, 334, 1897; SMITH, Bull. U. S. F. C. XVII, 90, 1898; BEAN, 52d Ann. Rep't N. Y. State Mus. 96, 1900; EVERMANN & MARSH, Bull. U. S. F. C. for 1900, 81, fig. 11, 1900.

Elops inermis MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 445.

Body elongate, subcylindric, compressed toward the tail, its greatest depth contained from five to six times in its length without caudal; caudal peduncle slender, its least depth three eighths of length of head; head moderate, obtusely conical, its length four and one fourth to four and one half in total without caudal, flattened above, with a broad, deep furrow between the eyes; eye large, one fifth as long as the head; upper jaw broad, rounded, entire, longer than the lower, which is received into it, the maxillary reaching far behind eye, almost to hind edge of preopercle; the gular plate three or four times as long as broad. D. 20; A. 13; V. 15; B. 30. Scales 12-120-13. Length 3 feet. Tropical and temperate seas; common in America, north to Virginia and the Gulf of California; occasional as far north as Cape Cod. Color bright silvery, with a greenish tinge along the back. Pupils black; iris golden; summit of the head bronzed; opercles with golden metallic tints; all the fins more or less punctate with black; dorsal and caudal light olive brown; lower fins tinged with yellow.

Mitchill found some individuals in the New York market in September 1813, under the name of salmon trout. One which he bought was 22 inches long and weighed 42 ounces. The fish were sold at 75c each, a remarkably good price for a species now generally considered unsalable because the flesh is dry and bony.

An adult was caught in Gravesend bay Oct. 5, 1896. Among the fishermen there it is known as "seering" and "cisco". Several examples, each about 1 foot long, were taken at Southampton L. I. in October 1898, by A. P. Latto, and presented to the State Museum.

At Cape Cod, according to Dr Smith, it is "common in fall, none appearing before October. Taken in traps in Vineyard sound and in herring gill nets at Vineyard Haven. Average length, 18 to 20 inches. No young observed."

The fish does not breed on our coast. The young are known to be ribbon-shaped and elongate and to pass through a remarkable series of changes similar to those observed in the ladyfish, Albula vulpes.

Family ALBULIDAE

Ladyfishes

Genus ALBULA (Gronow) Bloch & Schneider

Body rather elongate, little compressed, covered with rather small, brilliantly silvery scales; head naked; snout conical, subquadrangular, shaped like the snout of a pig, and overlapping the small, inferior, horizontal mouth; maxillary rather strong, short, with a distinct supplemental bone, slipping under the membranous edge of the very broad preorbital; premaxillaries short, not protractile; lateral margin of upper jaw formed by the maxillaries; both jaws, vomer, and palatines with bands of villiform teeth; broad patches of coarse, blunt, paved teeth on the tongue behind and on the sphenoid and pterygoid bones; eye large, median in head, with a bony ridge above it, and almost covered with an annular adipose eyelid; opercle moderate, firm, preopercle with a broad, flat, membranaceous edge, which extends backward over the base of the opercle; pseudobranchiae present; gill rakers short, tuberclelike; gill membranes entirely separate, free from the isthmus; branchiostegals about 14; a fold of skin across gill membranes anteriorly, its posterior free edge crenate; no gular plate; lateral line present; belly not carinate, flattish, covered with ordinary scales; dorsal fin moderate, in front of ventrals, its membranes scaly; no adipose fin; anal very small; caudal widely forked; pyloric caeca numerous; parietal bones meeting along top of head. Vertebrae numerous, 42+28—70. A single species known, found in all warm seas. In this, and probably in related families, the young pass through a metamorphosis, analogous to that seen in the conger eels. They are for a time elongate, band-shaped, with very small head and loose transparent tissues. From this condition they become gradually shorter and more compact, shrinking from 3 or 3½ inches in length to 2 inches. According to Dr Gilbert, this process, like that seen in various eels, is a normal one, through which all individuals pass. In the Gulf of California, where these fishes abound, these band-shaped young are often thrown by the waves on the beach in great masses. (After Jordan and Evermann)

105 Albula vulpes (Linnaeus)

Ladyfish; Bone Fish; Banana Fish

Esox vulpes Linnaeus, Syst. Nat. ed. X, I, 313, 1758.
Butirinus vulpes De Kay, N. Y. Fauna, Fishes, 268, 1842, name only.
Albula Parrae Cuvier & Valenciennes, Hist. Nat. Poiss. XIX, 339, 1846.
Albula erythrochilos Cuvier & Valenciennes, op. cit. 352, pl. 574, 1846.
Albula conorhynchus Günther, Cat. Fish. Brit. Mus. VII, 468, 1868.
Albula vulpes Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 258, 1883; Goode, Fish & Fish. Ind. U. S. I, 612, pl. 218, lower fig. 1884; Bean, 19th Rep. Comm. Fish. N. Y. Separate, 42, pl. XXIII, fig. 31, 1890; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 411, 1896, pl. LXVIII, fig. 179, 1900; Smith, Bull. U. S. F. C. XVII, 91, 1898; Evermann & Marsh, Bull. U. S. F. C. for 1900, 82, fig. 12, 1900.

Body fusiform, elongate, rounded, its greatest depth, at dorsal origin, contained four and two thirds times in total length to base of caudal fin and equal to distance from posterior nostril to end of head; caudal peduncle rather slender, its least depth about one third of greatest depth of body; head long, conical, the snout rather acutely pointed, length of head about three and two thirds in total; eye moderate, one half of snout, one fifth of head, placed high; mouth inferior, small, the maxilla not reaching to below front of eye; collar of enlarged scales on the nape extending down to the base of the pectoral; dorsal origin about midway between tip of snout and base of caudal, the base of the fin a little more than one half the length of head, the longest ray as long as the head without the snout, the last ray one third as long as the longest. The pectoral reaches to below the 15th scale of the lateral line. The ventral origin is under the 32d scale of the lateral line; the fin three eighths as long as the head. Anal origin equally distant from base of caudal fin and end of ventral base, the longest ray one third as long as head, the last ray less than one half as long as the longest; caudal fin long, deeply forked, the outer rays equal in length to hight of body. D. III, 14; A. I, 8; V. I, 10. Scales 8–75–8. Bright silvery; upper parts olivaceous; fins pale; axils of pectorals and ventrals dusky. Size large, length reaching 3 feet.

Tropical seas, on sandy coasts, on our coasts ranging northward to Cape Cod and San Diego. A valuable food fish, but

not esteemed in northern waters. Highly prized at Key West and the Bermudas; not much in favor at Porto Rico.

The ladyfish is found on our coast from Cape Cod to the Gulf of Mexico. It also occurs in the Bermudas and West Indies. The Bermuda names are bony fish and grubber. It is considered an excellent food fish on these islands, and Dr Goode testifies from personal experience to its value as an edible species. At Cozumel, off the coast of Yucatan, it is highly esteemed. On our coast it is occasionally found as far north as Cape Cod.

The ladyfish is not described by either Mitchill or DeKay as one of the fishes of New York; and I did not see it in Great South bay, but it was taken later in the fall by Capt. Lewis B. Thurber, of Patchogue, who forwarded it to me.

Dr Smith says it is very rare at Woods Hole Mass. where it was reported by Prof. Baird in 1871. Since 1871 it has been observed only once or twice, and none has been taken for many years.

Family HIODONTIDAE

Mooneyes

Genus HIODON Le Sueur

In the mooneyes the body is oblong, compressed, covered with cycloid silvery scales of moderate size. Head short, naked, with obtuse snout and no barbels. The mouth is terminal, of moderate size; jaws subequal. The margin of the jaw is formed by the nonprotractile intermaxillaries and the slender maxillaries, which are articulated to the end of the intermaxillaries. The opercular apparatus is complete. Intermaxillary and mandible with small cardiform teeth, wide set; feeble teeth on the maxillaries; a row of marginal teeth on the tongue, those in front very strong canines; a band of short close set teeth on middle of tongue; vomerine teeth small, close set, in a long double series; teeth on the palatine, sphenoid and pterygoid bones. The lower jaw is received within the upper so that the mandibulary teeth are opposite to those on the palatine bone. The very large eye has a little developed adipose eyelid. Nostrils large, close together, with a flap between them; gill membranes

deeply cleft, free from isthmus, their base covered by a fold of skin; branchiostegals 8 to 10; no pseudobranchiae; gill rakers short, thick and few in numbers; a straight and well developed lateral line; belly without scutes; no adipose fin; dorsal fin over the caudal part of the vertebral column; anal long and low; ventrals large; caudal deeply forked; stomach horseshoe-shaped, with blind sac; intestine short; one pyloric appendage; air bladder large and simple. The eggs fall into the abdominal cavity before exclusion.

106 Hiodon tergisus (Le Sueur)

Mooneye; Toothed Herring

Hiodon tergisus Le Sueur, Jour. Ac. Nat. Sci. Phila. I, 366, Sept. 1818, Ohio River and Lake Erie.

Hiodon clodalus Le Sueur, op. cit. 367, Sept. 1818, Pittsburg.

Glossodon harengoides Rafinesque, Amer. Month. Mag. III, 354, Sept. 1818, Ohio River.

Cyprinus (Abramis ?) Smithii Richardson, Fauna Bor.-Amer. III, 110, fig. 1836.

Hyodon tergisus De Kay, N. Y. Fauna, Fishes, 265, pl. 41, fig. 130; Cuvier & Valenciennes, Hist. Nat. Poiss. XIX, pl. 572, 1846; Günther, Cat. Fish. Brit. Mus. VII, 375, 1868; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 260, 1883; Goode, Fish & Fish. Ind. U. S. I, 613, pl. 219, 1884.

Hyodon clodalis De Kay, op. cit. 266, 1842, but fig. 164, pl. 51, represents *alosoides*.

Hyodon claudalus Cuvier & Valenciennes, Hist. Nat. Poiss. XIX, 313.

Hyodon tergisus Bean, Fishes Penna. 57, pl. 25, fig. 44 (named *alosoides*), 1893; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 413, 1896, pl. LXVIII, fig. 180, 1900.

The shape of the body is similar to that of the northern mooneye. The belly has a slight but obtuse keel in front of the ventrals and is compressed to a rather sharp edge behind the ventrals. Head short, its length two ninths of total without caudal; the eye much longer, about one third the length of head. The greatest depth of the body is nearly one third of total length. The pectoral is as long as the head without the snout; the ventral not much more than two thirds the length of head, its origin under the 18th scale of the lateral line. The anal origin is under the 7th developed ray of the dorsal. The longest anal ray is less than one half the head. The anal base is as long as the head; its last ray is less than one half the longest

ray. The anal has a deep notch. The longest dorsal ray is little more than length of dorsal base. The last ray is not much more than one half the longest. The caudal is deeply forked. D. 12; A. 28 to 32. Scales 6–58–8. Upper parts greenish in life, the sides and abdomen brilliant silvery.

This species is called mooneye, toothed herring and silver bass. It is found in Canada, the Great lakes region and the upper part of the Mississippi valley, being very common in large streams and lakes. It abounds in Lake Erie and the Ohio and is seined in large numbers. DeKay observed the fish in the Allegheny river, N. Y. He records it also from Buffalo and Barcelona, on Lake Erie, at which places it is known as mooneye, shiner, and lake herring. He says it is very indifferent food.

This species grows to a length of 1 foot and, like the other, though a beautiful fish and possessed of excellent game qualities, its flesh is full of small bones. It is a good fish for the aquarium; it will take a minnow or the artificial fly very readily, and the utmost skill is required in its capture. Its food consists of insects, small fishes and crustaceans.

Dr Richardson describes this fish as a member of the minnow family, which he says is known to the Canadians under the name *la quesche*. The fish is described as having the back brilliant green, sides and abdomen with a silvery luster. The specimens which were taken in the Richelieu, where it falls into the St Lawrence, were about 9 or 10 inches long.

107 Hiodon alosoides (Rafinesque)

Northern Mooneye; La Quesche

Amphiodon alosoides Rafinesque, Jour. Phys. Paris, 421, 1819. Ohio River.
Hyodon amphiodon Rafinesque, Ichth. Ohien. 42, 1820.
Hiodon chrysopsis Richardson, Fauna Bor.-Amer. III, 232, 1836.
Hyodon alosoides Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 259, 1883; Goode, Fish & Fish. Ind. U. S. I, 612, 1884.
Hiodon alosoides Bean, Fishes Penna. 57, 1893 (not figured); Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 413, 1896.
Hyodon clodalis De Kay, N. Y. Fauna, Fishes, pl. 51, fig. 164, not description, 1842.

Body deep, much compressed, its greatest depth equaling two sevenths of the total without caudal. The head is short, con-

taining the length of the eye about three and one half times and equaling a little more than one fifth of the total without caudal. The snout is very blunt, the mouth large and oblique, the maxilla reaching beyond the middle of the eye. There is a well developed keel along the entire length of the belly. D. 9; A. 32. Scales 6–56–7.

The general color is bluish silvery on the sides with golden reflections.

The northern mooneye is found from the Ohio river throughout the Great lakes region to the Saskatchewan. It is very common in Manitoba and other parts of British America. In Pennsylvania it is limited to the western region.

De Kay must have had the northern mooneye for study, though his description seems to apply to another species. The figure of his Hyodon clodalis represents a fish with a short dorsal fin, quite unlike his account in the text.

The northern mooneye is very readily distinguished from the other species of the genus by its short dorsal fin, which contains only nine rays, and by its carinated belly. It grows to the length of 1 foot. The flesh is not greatly esteemed as a rule, but the fish is beautiful and has excellent game qualities.

Richardson says the fish inhabits lakes which communicate with the Saskatchewan, in the 53d and 54th parallels of latitude, but does not approach nearer to Hudson bay than Lake Winnipeg. This we know to be a mistake. He says further that it is taken during the summer months only, and in small numbers, in gill nets set for other fish. It bites eagerly at an artificial fly or worm. Its flesh is white, resembling that of the perch in flavor, and excelling it in richness.

Family DOROSOMIDAE

Gizzard Shads

Genus DOROSOMA Rafinesque

The genus Dorosoma has a herringlike body, with a short and obtuse snout. The body is much compressed and is covered with moderately large, thin, cycloid scales. The head is scaleless, short and small; the eye large and provided with

an adipose eyelid. The belly is compressed to an edge, which is armed with sharp serratures. Mouth small, transverse; the lower jaw the shorter, jaws toothless. The maxilla does not extend to the middle of the eye. Gill rakers numerous, moderately long and slender; gill membranes deeply cleft and free from the isthmus; pseudobranchiae well developed; lateral line wanting. The dorsal fin is placed nearly over the middle of the body, slightly behind the origin of the ventral. Its last ray is produced into a long filament. The pectorals and ventrals are rather long and each is provided with an appendage formed of several elongate, overlapping accessory scales. The caudal is deeply forked. Anal very long, its last rays low. The stomach is stout and short, resembling the gizzard of a hen.

108 **Dorosoma cepedianum** (Le Sueur)

Gizzard Shad

Megalops cepediana Le Sueur, Jour. Ac. Nat. Sci. Phila. I, 361, Sept. 1818. (Baltimore and Philadelphia markets).

Clupea heterurus Rafinesque, Amer. Month. Mag. III, 355, Sept. 1818. Ohio River.

Dorosoma notata Rafinesque, Ichth. Ohien. 40, 1820. Ohio River.

Chatoëssus cepedianus and *clupeicus* De Kay, N. Y. Fauna, Fishes, 265, 1842, as extra-limital.

Chatoëssus clupeicus Kirtland, Bost. Jour. Nat. Hist. IV, 235, pl. X, fig. 1, 1844.

Chatoëssus cepedianus Cuvier & Valenciennes, Hist. Nat. Poiss. XXI, 99, pl. 612, 1848. New York, Philadelphia, New Orleans; Günther, Cat. Fish. Brit. Mus. VII, 409, 1868.

Dorosoma cepedianum Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 271, 1883; Goode, Fish. & Fish. Ind. U. S. I, 610, pl. 217 A, 1884; Bean, Fishes Penna. 63, 1893; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 416, 1896, pl. LXIX, fig. 183, 1900.

The depth of the body is contained two and two thirds times in the total without caudal, the length of the head four and one third times. Eye longer than snout, one fourth length of head. The third ray of the dorsal is two thirds as long as the head, and the filamentous ray nearly equals the head in length. Length of dorsal base about one half that of head; anal base two sevenths of total length of body without caudal, its longest ray two thirds of length of ventral or one third of that of head. Pectoral three fourths as long as head. Lower caudal lobe

longer than upper, its length equal to that of the head. D. iii, 10; A. ii, 31. Scales 56 to 64, about 20 in a transverse series. Scutes in front of ventrals 17, and from ventral to vent 12. Upper parts bluish; sides silvery, sometimes with golden reflections. In young individuals there is a large dark blotch on each side not far behind the head. This disappears with age.

The mud shad, also known as gizzard shad, winter shad, stink shad, white-eyed shad, hickory shad, hairy back, and thread herring, is found in brackish waters along the coast from New York southward to Mexico, ascending streams and frequently becoming landlocked in ponds. A variety of this fish is also common in the Ohio and Mississippi valleys, whence it has spread through canals into Lakes Erie and Michigan.

Cuvier and Valenciennes had the species from New York, whence it was sent by Milbert. De Kay mentions it only as an extralimital fish; but in his time the fish fauna of Lake Erie was very little known.

This fish grows to a length of 15 inches and a weight of 2 pounds. It spawns in summer, and its food consists of algae, confervae, desmids and diatoms. With its food it takes large quantities of mud, from which it separates the organic substances after swallowing. This is a beautiful species, somewhat resembling the shad in general appearance and has been very successfully kept in the aquarium, where its bright colors and graceful movements make it attractive, but its flesh is soft, tasteless and seldom eaten when any better can be obtained. In most regions fishermen consider it a great nuisance and throw away their entire catch. Negroes eat the mud shad from tributaries of the Chesapeake, and in Florida the fish has been utilized to some extent in making guano. The name gizzard shad alludes to the form of the stomach, which is very much like that of a hen.

Family CLUPEIDAE

Herrings

Body oblong or elongate, more or less compressed, covered with cycloid or pectinated scales; belly sometimes rounded, sometimes compressed, in which case it is often armed with

bony serratures; head naked, usually compressed; mouth rather large, terminal, the jaws about equal, maxillaries forming the lateral margins of the upper jaw, each composed of about three pieces; premaxillaries not protractile; teeth mostly small, often feeble or wanting, variously arranged; adipose eyelid present or absent; gill rakers long and slender, gill membranes not connected, free from the isthmus; no gular plate; gills four, a slit behind the fourth; branchiostegals usually few (6 to 15); posterior lower part of opercular region often with an angular emargination, the tips of the larger branchiostegals being abruptly truncate; pseudobranchiae present; no lateral line. Dorsal fin median or somewhat posterior, rarely wanting; no adipose fin; ventrals moderate or small (wanting in Pristigaster); anal usually rather long; caudal fin forked. Vertebrae 40 to 56. Genera about 30; species 150; inhabiting all seas, and usually swimming in immense schools; many species ascend fresh waters, and some remain there permanently. The northern and fresh-water species, as in many other families, differ from the tropical forms in having a larger number of vertebral segments.

Genus ETRUMEUS Bleeker

Body rather elongate, somewhat compressed; the abdomen rounded and without serratures; mouth terminal, of moderate width, formed as in Clupea, but the maxillary more slender; teeth moderate, in patches on jaws, palatines, pterygoids, and tongue; scales cycloid, entire, very deciduous; branchiostegals numerous, very slender. Ventrals inserted posteriorly, entirely behind dorsal; the dorsal fin rather long, of 18 to 20 rays; anal low, of moderate length. Pseudobranchiae well developed; pyloric caeca numerous. No silvery lateral stripe. Few species, Asiatic and American. (After Jordan and Evermann)

109 Etrumeus teres (De Kay)

Round Herring

Alosa teres De Kay, N. Y. Fauna, Fishes, 262, pl. 40, fig. 128, 1842. New York harbor.

Etrumeus teres Günther, Cat. Fish. Brit. Mus. VII, 467, 1868; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 263, 1883; Bean, Bull. U. S. F. C. VII, 148, 1888; 19th Rep. Comm. Fish. N. Y. separate, 44, 1890.

Etrumeus sadina Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 420, 1896, not *Clupea sadina* Mitchill; Smith, Bull. U. S. F. C. XVII, 91, 1898.

Body slender, rounded, elongate, its greatest depth one sixth of total length without caudal; head rather long, one fourth of total without caudal; mouth small, the jaws subequal in front, the maxilla extending to or slightly beyond the front of the eye; the mandible not at all projecting when the mouth is closed, but rather included; thickness of body more than two thirds of its depth; vomerine teeth present, lingual teeth well developed, teeth in the jaws weak; eye large, equal to snout, three and one third in length of head; dorsal origin midway between tip of snout and origin of anal, the longest dorsal ray more than one half length of head; ventrals well behind dorsal, the length little more than one third length of head; anal basis short, about one third length of head; axillary scales above pectorals and ventrals very long, those over the pectoral more than one half as long as the fin. D. 18; A. 13. Color, bright silvery; darker above, with a tinge of blue and yellow on the sides. Head metallic silvery with coppery reflections; iris golden; dorsal and caudal tinged with yellow, the remaining fins translucent, with minute dark specks. Cape Cod to the Gulf of Mexico, not rare southward; a favorite food of bluefish.

The "New York shadine" of Mitchill can not be identified with this species; it was evidently a species of Pomolobus bearing a close resemblance to the shad. Mitchill's shadine had a spot behind the gill cover, a wide and toothless mouth, a projecting lower jaw and 15 anal rays. These characters are in opposition to the known characters of the round herring, and there is no probability that this little fish was before him for description. De Kay saw only a single specimen of the round herring from the harbor of New York. A copy of Mitchill's[1] description is here given for comparison.

13 *New York Shadine*, Clupea sadina

An elegant species with a small smutty spot behind the gill cover; but with neither spots nor stripes on its back or sides. Mouth wide and toothless. Tongue small.

Back delicately variegated with green and blue. Lateral line straight. Sides silvery white, considerably above that line; and

[1] Mitchill. Lit. and Phil Soc. N. Y. Trans. 1815. 1:457.

below it quite to the belly. The white reflects vividly green, red, and other splendid hues. Head rather elongated. Lower jaw projecting.

Scales very easily deciduous. Form neat, taper, and slender. Gills rise into the throat on each side of the root of the tongue. Eyes pale and large. Tail deeply forked. On account of the even connection of the false ribs, the belly is not at all serrated, but quite smooth. A semitransparent space in front of the eyes from side to side.

Rays: Br. 7; P. 16; V. 9; D. 18; A. 15; C. 19.

This species was not taken in Great South bay, but on the ocean beach adjacent to the Blue Point lifesaving station.

It is the slender herring described by Dr DeKay from a single specimen taken with a seine in New York harbor in the latter part of October. He found it associated with numerous specimens of the big-eyed herring, E l o p s s a u r u s. DeKay states that the E l o p s appeared to be known to the fishermen as the round herring, but the name is more applicable to the little species now under consideration. Several specimens were seined on the ocean beach at Blue Point Lifesaving station, October 7. None were obtained in the bay. September 24, 51 examples of this fish were found lying on the beach, in the vicinity of the same station, having been driven ashore by bluefish. In August 1890 great schools of round herring were stranded in this way. Prof. Baird found a number of specimens along the beach of Great Egg Harbor bay in 1854, and a single specimen was seined by Capt. Thomas Steelman in the same locality in October 1887.

Young individuals, from $4\frac{1}{2}$ to $4\frac{3}{4}$ inches long, were taken in Gravesend bay July 30, 1896. They were associated with young mackerel, of slightly larger size, in bunches and schools. John B. DeNyse saw some schools that he estimated to contain 25,000 fish.

Dr Smith says it is apparently rare at Woods Hole; known to have been found on only a few occasions. In October, some years ago, several were taken in traps at Menemsha bight, Marthas Vineyard.

Genus CLUPEA (Artedi) Linnaeus

True herrings with the body elongate, numerous vertebrae, the ventral serratures weak, and an ovate patch of small but persistent teeth on the vomer. The few species belong to the northern seas, where the number of individuals is inordinately great, exceeding perhaps those of any other genus of fishes. Not anadromous, spawning in the sea.

The genus Clupea, which includes the shad, river alewife or herring and the Ohio golden shad or skipjack, admits of division into several subgenera, one of which includes the common sea herring and other marine species, another the shad and still another the river alewives. The last have the suborbital bone longer than deep and are supplied with teeth on the tongue and in some species in the jaws.

110 Clupea harengus Linnaeus

Sea Herring

Clupea harengus LINNAEUS, Syst. Nat. ed. X, I, 317, 1758; MITCHILL, Amer. Month. Mag. II, 323, Mar. 1818; CUVIER & VALENCIENNES, Hist. Nat. Poiss. XX, 30, pl. 591, 1847; GÜNTHER, Cat. Fish. Brit. Mus. VII, 415, 1868; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 265, 1883; GOODE, Fish & Fish. Ind. U. S. I, 549, pl. 204, 1884; BEAN, 19th Rep. Comm. Fish. N. Y. separate, 42, pl. XXIV, fig. 32, 1890; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 421, 1896, pl. LXX, fig. 185, 1900; SMITH, Bull. U. S. F. C. XVII, 91, 1898.

Clupea halec MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 451, 1815.

Clupea pusilla MITCHILL, op. cit. 452, 1815.

Clupea coerulea MITCHILL, op. cit. 457, 1815.

Clupea elongata DE KAY, N. Y. Fauna, Fishes, 250, 1842; STORER, Hist. Fish. Mass. 152, pl. XXVI, fig. 1, 1867.

Body elongate, slender, fusiform, compressed, its greatest depth one fourth of total length without caudal; caudal peduncle slender, its least depth one third of length of head; head moderate, two ninths of total length without caudal; eye large, three and one half to four in head, and with a well developed adipose eyelid; lower jaw strongly projecting; maxilla reaching to below middle of pupil, its length three sevenths of length of head; cheeks longer than high; an ovate patch of small teeth on vomer, palatine teeth minute or wanting, small teeth on the tongue, small teeth in the jaws in young examples, usually dis-

appearing with age; gill rakers very long and slender, about 40 on the lower part of the first arch; dorsal origin midway between tip of snout and end of scales, dorsal base one eighth of total length without caudal, longest dorsal ray equal to postorbital part of head, last dorsal ray one half the length of longest; ventral under about middle of dorsal, its length three eighths of head; anal base a little shorter than dorsal base, its longest ray one fifth, and its shortest ray one tenth of greatest depth of body; caudal fin well forked, its longest rays three fourths of head; pectoral fin about two thirds as long as the head. Scales very deciduous. Abdomen with weak serratures, before and behind the ventrals, 28 scutes in front of and 13 behind the ventrals. D. 18; A. 17. Scales 14–57. Vertebrae 56. Peritoneum dusky; back and head deep blue, tinged with yellow; opercles yellowish, tinged with violet; iris silvery; sides silvery with bright reflections. Length 12 to 17 inches. North Atlantic ocean, on our east coast south to Cape Hatteras, spawning in the sea.

The sea herring is the most important food fish of the world and it is undoubtedly the most abundant of all the fishes. Its food consists of small invertebrates, chiefly copepods and the larvae of worms and mollusks. It forms the most important food of many of our valuable food fishes including the cod, haddock, halibut, bluefish, and a great many others. Herring spawn at two seasons, spring and fall, the first spawning continuing from April to June and the second season between July and December. The eggs are adhesive and are deposited on the bottom, where they adhere to seaweeds and other objects of support. The egg is about $\frac{1}{50}$ inch in diameter. The hatching period lasts from 12 days to 40 days, according to the temperature of the water. Sea herrings were artificially hatched as early as 1878, both in Germany and in the United States. It has been estimated that the annual yield of sea herring is 3,000,000,000 fish, principally taken in Norway.

The herring occurs on our east coast from Labrador to New York. When found as far south as New York, it usually occurs

in midwinter. Capt. Thurber obtained it in Great South bay in the fall.

The young of the sea herring is well known as the whitebait of England and the United States, though in the latter country the young of other species are sometimes mingled with those of the sea herring.

Many young, translucent fish of the genus Clupea, a little under 2 inches long, are seen in spring in the shad fykes and pounds of Gravesend bay. They are called "shad bait," because they are said to be taken frequently from shad stomachs. John B. De Nyse brought some of them to me for examination Ap. 30, 1896. They showed the following characters.

D. 18; A. 17. Muscular impressions along sides of body about 60. The ventral is very slightly in advance of the origin of the dorsal. Intestinal tract full of minute orange-colored substances resembling entomostraca. A row of black dots on sides, low down, extending from pectoral to anal. Iris silvery; top of eye very dark.

Large sea herring, according to W. I. De Nyse, are rare in Gravesend bay. Only about 100 or 200 are obtained there during fall and winter.

Young examples, from 4¾ to 6 inches long, were obtained in that bay Nov. 23, 1897.

In the vicinity of Woods Hole Mass., according to Dr Smith, schools of large herring, in a spawning condition, appear about October 15 and remain till very cold weather sets in, their departure corresponding with that of the cod. By January young herring ¼ inch long are taken in surface tow nets; by May 1 they are 1 to 1¼ inches long, and by August 1, 2½ to 3 inches. Fish 3 to 5 inches long, called "sperling," are found from September 1 to end of season and are used for mackerel bait. About June 1 there is a large run of herring, smaller than those in the fall run. This lasts two weeks, during which the traps are full of them. No use is made of the early run, but in fall they are caught in gill nets for food and bait.

Genus POMOLOBUS Rafinesque

Body oblong, more or less compressed; mouth moderate, terminal, the jaws about equal, or the lower projecting, the upper scarcely notched at tip; teeth feeble, variously placed, probably never wholly absent, mandibles very deep at base, shutting within the maxillaries; gill rakers more or less long and slender, numerous; adipose eyelid present; scales thin, cycloid, deciduous, entire, rounded posteriorly; cheeks with the free part longer than deep; dorsal fin rather short, nearly median, beginning in advance of ventrals, its posterior ray not prolonged in a filament; ventral present; anal moderate; belly compressed, strongly serrated before and behind ventrals. Flesh rather dry and poor, less oily than in Clupanodon. Vertebrae 46 to 55 in number, usually 50. Species numerous, mostly anadromous.

111 Pomolobus chrysochloris Rafinesque

Skipjack; Blue Herring; Gold Shad

Pomolobus chrysochloris RAFINESQUE, Ichth. Ohien. 39, 1820. Ohio River; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 425, 1896, pl. LXX, fig. 187, 1900.

Meletta snoerii CUVIER & VALENCIENNES, Hist. Nat. Poiss. XX, 375, 1847.

Alosa chrysochloris KIRTLAND, Bost. Jour. Nat. Hist. IV, 307, pl. XV, fig. 3, 1844.

Clupea chrysochloris JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 266, 1883; GOODE, Fish & Fish. Ind. U. S. I, 594, pl. 211, 1884; BEAN, Fishes Penna. 59, 1893.

This species has a few strong and distinct teeth in the jaws, the lower jaw strongly projecting, the caudal peduncle stout and the belly strongly serrated. In shape the body resembles that of the sea herring; it is compressed, rather low, its depth slightly more than one fourth of the total length without caudal and about equal to the length of the head. The eye is large, nearly one fourth the length of head; the maxilla extends nearly to the hind margin of the eye; the length of the upper jaw is more than one half the length of head. The origin of the dorsal is over the ninth series of scales, and the length of its base corresponds with 10 rows of scales. The ventral origin is under

the middle of the dorsal; the fin is one half as long as the head. The pectoral reaches the 14th series of scales of the lateral line; its length is two thirds of that of the head. The anal is moderately long and low; its longest ray about twice the length of eye and one half the length of its base. The longest dorsal ray equals postorbital part of head. The caudal is deeply forked. There are 23 gill rakers below the angle of the first arch. D. iii, 15; A. iii, 16. Scales 15-52 to 58. Scutes 20-13 to 14.

The body is blue with reflections of green and gold; the lower parts silvery.

The golden shad or skipjack is a common inhabitant of the Ohio and Mississippi valleys and the Gulf of Mexico. In Pennsylvania this fish is confined to the Ohio and its tributaries. It prefers large streams. It has made its way into the Great lakes through canals. The presence of the golden shad in the salt water of the Gulf of Mexico was discovered by Silas Stearns near Pensacola Fla. This species grows to a length of 18 inches.

Unlike most other species of herring, this one, according to observations of Prof. S. A. Forbes of Illinois, is predaceous, feeding on other fishes. Two examples examined by him had eaten gizzard shad, Dorosoma, and another one, individuals of some unidentified fish. The young of the golden shad, 2¼ inches long, had consumed nothing but terrestrial insects, including flies, small spiders, etc.

As far as I can learn it never ascends small streams. In the lower part of the Mississippi valley it migrates into salt water. In the upper portion of this region its permanent residence is in fresh water. The name skipjack is given in allusion to its habit of skipping along the surface of the water.

The fish is full of small bones, and its flesh is reputed to be tasteless and without value as food; yet Kirtland says it is esteemed in Ohio as a good pan fish. In the water its movements are graceful and active, and its peculiarity of leaping above the surface when in pursuit of its prey is interesting and unusual in this family.

112 Pomolobus mediocris (Mitchill)

Hickory Shad; Fall Herring; Shad Herring

Clupea mediocris Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 459, 1815. New York; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 266, 1883; McDonald, Fish & Fish. Ind. U. S. I, 607, pls. 216A, 216B, 1884; Bean, 19th Rep. Comm. Fish. N. Y. separate, 43, pl. XXV, fig. 34, 1890.

Clupea mattowaca Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 451, 1815. Long Island.

Clupea virescens De Kay, N. Y. Fauna, Fishes, 252, pl. 13, fig. 37, 1842.

Alosa mattowaca De Kay, N. Y. Fauna, Fishes, 260, pl. 40, fig. 127, 1842.

Alosa lineata Storer, Hist. Fish. Mass. 162, pl. XXVII, fig. 2, 1867.

Clupea mattowaca Günther, Cat. Fish. Brit. Mus. VII, 438, 1868.

Pomolobus mediocris Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 425, 1896, pl. LXXI, fig. 168, 1900; Smith, Bull. U. S. F. C. XVII, 91, 1898; Bean, 52d Ann. Rep. N. Y. State Mus. 96, 1900.

Head comparatively long, its length being contained four times in that of the body; the profile straight, and not very steep, form more elliptic than in others, and less heavy forward; lower jaw considerably projecting, upper jaw emarginate. The depth of the body is contained three and three eighths times in the length. Opercles rather less emarginate below and behind than in P. pseudoharengus. Fins low; dorsal fin inserted nearer snout than base of caudal. Bluish silvery; sides with rather faint longitudinal stripes. Peritoneum pale. Length 24 inches. Cape Cod to Florida; rather common; not highly valued as a food fish; not ascending streams to spawn. D. 15; A. 21. Lateral line 50; abdominal scutes 20+16.

This species is referred to by Dr Mitchill as the Staten Island herring, Clupea mediocris, which he says grows very large for a herring, being frequently 18 inches long and almost as big as a small shad. It has "six or eight brown spots, longitudinally, below the lateral line, as reported by an inhabitant of that part of the bay of New York which borders on Staten Island." Mitchill, also, has the same species under the name of Long Island herring, Clupea mattowaca. This, he says, is also called the autumnal or fall herring, as well as shad herring and fall shad. Mitchill recognized it as probably the full-grown fish of the C. mediocris. He was not able to distinguish it from that species. The length of the greenback,

according to this writer, frequently reaches 2 feet with a depth of from 4½ to 6 inches. At the time of his writing the fish was taken in October and November in seines on the surf side of the beaches fronting Long Island. Dr DeKay mentions examples in the market early in July, which are brought from the Connecticut river, where they are called weesick. He states that the specific name bestowed on it by Mitchill was derived from the aboriginal name of the island, Mattowaca or Mattowax. In Great South bay the name greenback is well established for the species. A single example was seined September 29 at Fire island. Oct. 1, 1890, considerable numbers of large greenbacks were caught in a trap at Islip. The hickory shad is caught in Gravesend bay during September, October and November, but is less plentiful than it was formerly. Large hickory shad, weighing from ½ pound to 2½ pounds, were shipped from waters near New York city to Fulton market Oct. 30, 1896. Each of them had in its stomach from 15 to 20 sand lance from 3½ to 5 inches long. A few specimens were seined at Blue Point cove, Great South bay, and at Howell's point, in the same bay, Aug. 31, 1898.

At Woods Hole Mass. it comes in the spring, but is most numerous late in September and till trap fishing ends. In October 1895 a trap near Tarpaulin cove caught 3500 at one lift. These brought 10c each in New York. In spring and summer the fish has no market value, but it sells in the fall.

The name hickory shad is applied to this species from the Chesapeake bay region southward, and in some Georgia rivers this is abbreviated to hicks. In the Potomac, and some other rivers tributary to the Chesapeake, the name tailor shad is applied to this fish. The hickory shad occurs from Maine to Florida, entering rivers except in New England. The species is much less valuable than the shad, for which it is often sold by dealers. Nothing definite is known about its habits, but Marshall McDonald was of the opinion that it spawns in the rivers at a little earlier period than the shad, which it always precedes in the ascent of the streams in spring.

113 Pomolobus pseudoharengus (Wilson)

Branch Herring; Alewife

Clupea pseudoharengus Wilson, Rees's Encycl. IX, about 1811.

Clupea vernalis Mitchill, Rep. Fish. N. Y. 22, 1814; Trans. Lit. & Phil. Soc. N. Y. I, 454, 1815; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 267, 1883; Bean, Fish & Fish. Ind. U. S. I, 588, 1884; Fishes Penna. 58, pl. 25, fig. 45, 1893; Goode, Fish & Fish. Ind. U. S. I, pls. 207, 208, 1884.

Alosa tyrannus De Kay, N. Y. Fauna, Fishes, 258, pl. 13, fig. 38, 1842.

Pomolobus vernalis Goode & Bean, Bull. Essex Inst. 24, 1879.

Pomolobus pseudoharengus Gill, Rep. U. S. F. C. I, 811, 1873; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 426, 1896, pl. LXXI, fig. 189, 1900; Smith, Bull. U. S. F. C. XVII, 91, 1898; Bean, 52d Ann. Rep. N. Y. State Mus. 96, 1900.

Body deep and heavy forward, much compressed. Its greatest depth, at dorsal origin equals one third of total length to base of caudal. The least depth of caudal peduncle equals but one half of length of head. The head is short, being almost as deep as long, about one fifth of the standard length. The eye is large, deeper than long, its length slightly greater than its distance from tip of snout—about three and one half in head. Maxillary broad, extending to the vertical through pupil; upper jaw emarginate, lower jaw slightly projecting. Length of dorsal base almost equal to that of head; its highest ray about two thirds as long as the base, or equal to anal base. The anal is low, its longest ray being equal to length of eye. Caudal deeply forked, partially scaled near base. Length of pectoral less than that of dorsal base. D. 16; A. 17 to 19. Scales 15–50 to 54.

In the male the dorsal is higher, its longest ray about equal to length of dorsal base, or two thirds the length of head.

Color on black blue silvery and paler on sides and underneath; a black spot behind head; dusky lines on body, which are only visible on large examples.

Described from no. 27197 U. S. National Museum from Potomac river. Length 11 inches.

The branch herring, river herring or alewife has a variety of additional names. It is the ellwife or ellwhop of Connecticut river, the spring herring of New York, the big-eyed and wall-

eyed herring of the Albemarle, the sawbelly of Maine, the grayback of Massachusetts, the gaspereau of Canada, little shad of certain localities, and the Cayuga lake shad of New York. The recorded range of the branch herring is from the Neuse river, N. C., to the Miramichi river, in New Brunswick, ascending streams to their head waters for the purpose of spawning. The fish is found abundant in Cayuga and Seneca lakes, N. Y., where it has probably made its way naturally. In Lake Ontario, since the introduction there of the shad, the alewife has become so plentiful as to cause great difficulty to fishermen, and its periodical mortality is a serious menace to the health of people living in the vicinity. The belief is that the fish were unintentionally introduced with the shad. In Pennsylvania the branch alewife occurs in the Delaware and the Susquehanna in great numbers in early spring.

The U. S. Fish Commission, in 1894, obtained specimens at the following localities of the Lake Ontario region.

Cape Vincent	June 21
Grenadier island	June 27
Mouth Salem river, Selkirk	July 25
Long pond, Charlotte, N. Y.	Aug. 17
Lake Shore, mouth Long pond	Aug. 17
Sandy creek, North Hamlin	Aug. 20

Not a native of Cayuga lake but often found there in large numbers. Known to the fishermen as sawbelly. It is thought to have been introduced into the lakes of central New York by the state fish commission. Large numbers are often found dead on the shores of Seneca and Cayuga lakes. (After Meek) De Kay says it appears in New York waters with the shad about the first of April, but never in sufficient numbers to form a separate fishery.

The branch herring, or alewife, is the first of the alewives to appear in Gravesend bay; it comes with the shad. It endures captivity well. Nov. 30, 1897, individuals above 7 inches in length were caught in Gravesend bay, which were probably the young of the year.

This alewife seldom exceeds 1 foot in length, the average market examples being about 10 inches. The weight of the largest is about ½ pound, and the average weight is about 5 or 6 ounces.

The fish enter the rivers earlier than the shad and return to the sea, or to estuaries adjacent to the river mouths, at some undetermined date in the fall. During the summer months enormous schools of full grown, but sexually immature alewives migrate along the coast, feeding on small crustaceans and themselves furnishing food for bluefish, sharks, porpoises and other predaceous animals; but none of them are known to enter fresh waters. In the rivers the alewives appear to eat nothing, but they can be captured with small artificial flies of various colors. Their eggs are somewhat adhesive and number from 60,000 to 100,000 to the individual. They are deposited in shoal water; spawning begins when the river water is at 55° to 60° F. The period of hatching is not definitely known, but is believed to exceed four days.

During the spring and summer the young grow to a length of 2 or 3 inches; after their departure from the streams nothing is known of their progress, but it is believed that they reach maturity in four years. We have no means of learning the age of the immature fish seen in great schools off shore, and thus far the rate of growth is unsettled.

The branch alewife, though full of small bones, is a very valuable food fish and is consumed in the fresh condition as well as dry salted, pickled and smoked. The fry can be reared in ponds by placing adults in the waters to be stocked a little before their spawning season; and they furnish excellent food for bass, rockfish, trout, salmon, and other choice fishes. The proper utilization of the immense oversupply of these fish in Lake Ontario has become a serious economic problem.

Alewives are caught in seines, gill nets, traps and pounds and they are often taken by anglers with artificial flies.

114 Pomolobus cyanonoton (Storer)

Glut Herring; Blueback

Alosa cyanonoton Storer, Proc. Bost. Soc. Nat. Hist. II, 242, 1848, Hist. Fish. Mass. 161, pl. XXVII, fig. 1, 1867.

Pomolobus aestivalis Goode & Bean, Bull. Essex Inst. 24, 1879; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 426, 1896, pl. LXXI, fig. 190, 1900; Smith, Bull. U. S. F. C. XVII, 91, 1898.

Clupea aestivalis Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 267, 1883; McDonald, Fish & Fish. Ind. U. S. I, 579, pls. 209, 210, 1884, not *Clupea aestivalis* Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 456, pl. V, fig. 6, 1815.

Body moderately deep and compressed, its greatest depth two sevenths of the length without caudal; least depth of caudal peduncle two sevenths of greatest depth of body; head short, one fifth of total length without caudal, the maxilla extending to below the middle of the eye, its width about one third of its length, lower jaw somewhat projecting, upper jaw notched; eye smaller than in P. pseudoharengus, equal to snout and one fourth of length of head, chiefly covered by an adipose membrane; gill rakers about 44 below and 21 above the angle of the first arch, the longest about equal to iris; lower caudal lobe the longer, about equal to length of head. Dorsal fin begins in advance of ventral origin, over the 13th row of scales; the longest ray is about three fourths as long as the base of the fin and twice as long as the last ray. Anal base two and one half times as long as the longest ray and as long as the head without the snout. Ventral under the 6th developed ray of dorsal, the fin one half as long as the head; its axillary scale about one half as long as the ventral fin. A small black spot behind the opercle on the level of the top of the eye. Narrow dark streaks on about five rows of scales above the median line. Peritoneum very dark. D. iii, 15; A. ii, 18; V. i, 8; P. i, 15. Scales 13–53; scutes 21 + 14. Above bluish, sides and gill covers with coppery reflections, lower parts silvery. Irish golden. Here described from a male specimen taken in the Potomac river and now in the U. S. National Museum.

Mitchill's name, aestivalis, can not be applied with any certainty to the "glut herring"; it appears to be a synonym of

mediocris and mattowaca of the same author. Its relation to mattowaca was long since pointed out by Dr Gill. The description[1] herewith appended appears to make this conclusion inevitable.

Summer herring of New York (Clupea aestivalis). Has a row of spots to the number of seven or eight, extending in the direction of the lateral line. Tail forked. Belly serrate; and, in most respects, resembling the C. halec, herein already described. Rays: Br. 6; P. 15; V. 9; D. 16; A. 19; C. 19.

The figure shows a row of eight dark spots on the side extending as far back as the end of the dorsal fin on the level of the eye. This resembles the hickory shad, Pomolobus mediocris, more than anything else, and it probably was that species.

The glut herring arrives later than the branch herring and does not ascend streams far above salt water. It appears to spawn only in the larger streams or their tidal tributaries and at a temperature of 70° to 75°; while the branch herring spawns in water as low as 55° to 60° and ascends far up the streams and their small fresh-water branches.

In Gravesend bay the glut herring is called shad herring. Nov. 30, 1897, two young fish of the year, measuring about 7 inches in length, were obtained from that bay. In Great South bay the species is called herring. A single example was secured there on Sep. 29, 1890. In 1898 it was not collected either in Great South bay or Mecox, in both of which the branch herring was abundant.

At Provincetown the species is known as the blueback and kiouk. According to Storer, it appears there in small numbers in May, but is not abundant before June 10, and it remains on the coast for a short time only. The alewife, or branch herring, arrives on the coast of Massachusetts about the end of March, and is taken till the middle or last of May.

Genus ALOSA Cuvier

Body deep, compressed, deeper than in related American genera, the head also deep, the free portion of the cheeks deeper

[1] Mitchill. Lit. and Phil. Soc. N. Y. Trans. 1815. p. 456, pl. 5, fig. 6.

than long; jaws wholly toothless (except in young); upper jaw with a sharp, deep notch at tip, the premaxillaries meeting at a very acute angle. Vertebrae 56 (in Alosa alosa), otherwise as in Pomolobus, to which genus Alosa is very closely allied. Species three, of the north Atlantic, ascending rivers; highly valued as food fishes. Though very full of small bones, the flesh is white and rich, but not oily.

115 Alosa sapidissima (Wilson)

Shad

Clupea sapidissima Wilson, Rees's New Cyclopedia, IX, about 1811, no pagination, no date; Rafinesque, Amer. Month. Mag. II, 205, Jan. 1818, says Wilson first distinguished and named the Shad; McDonald in Fish & Fish. Ind. U. S. I, 594, pls. 212, 213, 1884; Bean, Fishes Penna. 60, pl. 2, 1893; Cheney, 4th Ann. Rep. N. Y. Comm. Fish. colored plate facing p. 8, 1899.

Clupea alosa Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 449, 1815.

Alosa praestabilis De Kay, N. Y. Fauna, Fishes, 255, pl. 15, fig. 41, 1842; Storer, Hist. Fish. Mass. 154, pl. XXVI, fig. 2, 1867.

Alosa sapidissima Linsley, Am. Jour. Sci. Arts, XLVII, 70, 1844; Storer, Syn. Fish. N. A. 206, 1846; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 427, 1896, pl. LXXII, fig. 191, 1900; Smith, Bull. U. S. F. C. XVII, 91, 1898.

The American Shad. Goode, American Fishes, 400, fig. 1888.

The shad was formerly referred to the genus Clupea, but differs from the typical sea herring in the shape of the cheek bone, which is somewhat deeper than long. The adult is toothless, but the young has well developed, though small, teeth in the jaws, which sometimes persist till the fish has reached a length of 15 inches. To this subgenus the name Alosa was given by Cuvier.

The shad has a deep body and a large mouth, with the jaws about equal. The gill rakers are very long and slender, varying with age from 40 to 60 below the angle of the first arch. In the female the dorsal originates a little in front of the middle of the length; in the male somewhat farther in front. The dorsal of the male is rather higher than that of the female, while the body is not so deep. In the female the greatest depth is one third of the total without caudal and the length of the head two ninths. In the male the length of the head is one

fourth of the total without caudal. The dorsal has 13 divided rays and 4 simple ones; anal 19 divided and 3 simple. Scales 16—60 to 65. Scutes 22-16.

The color is bluish or greenish with much silvery; a dusky blotch close behind the head, two thirds as large as the eye, and frequently from several to many, in one or two rows, behind this. The lining of the belly walls is pale.

The shad is known also as the white shad, and in the colonial days it was known to the negroes on the lower Potomac river as the whitefish. It is found naturally along the Atlantic coast of the United States from the Gulf of St Lawrence to the Gulf of Mexico, ascending streams at various dates from January in its extreme southern limit to June in far northern waters. In the Delaware and Susquehanna it makes its appearance in April and departs after spawning; but remains sometimes as late as July 18, and many die.

The original distribution of the shad has been widely extended by artificial introduction. In certain rivers flowing into the Gulf of Mexico the fish has been established by planting. In the Ohio river a fishery has been created by the same method; and in the Sacramento river, Cal., the shad was successfully introduced, and it has colonized not only this river but all suitable rivers from San Francisco to southern Alaska. It is now one of the common market species in San Francisco and other west coast cities.

In the Susquehanna the shad was formerly one of the most important native food fishes, but its range is now very limited on account of obstruction by dams. 20 years ago the fish commissioners reported that a few shad are taken yearly above the Clark's Ferry dam, none or at most a few dozen above the Shamokin dam, none above the Nanticoke dam and none above Williamsport. The largest run of shad that has been known to pass the Columbia dam was that of 1867. "In 1871 the finest Columbia shad were hawked in the market at Harrisburg, 30 miles from the fisheries, at considerably less than a dollar a pair. The catch at Columbia exceeded 100,000."

The obstructions in the Delaware have been almost entirely overcome. In 1891 shad were caught higher up the Delaware than for many years, and spawned in the upper reaches of the river beyond the New York state line. In 1891 the Delaware, for the first time since 1823, was restored to its normal condition by means of the fishway at Lackawaxen; and, according to Col. Gay, it is at present the best shad river in the country. The number of eggs obtained for artificial propagation in the lower river was unusually small, but the number naturally deposited in the upper waters was greater than for many years. Col. Gay observed a large number of big female shad at Gloucester City, but a great scarcity of males. This necessitated a long run up the river before spawning. The cause is believed to be the low temperature of the water during May, the lack of rain cutting off the usual supply of warm surface water and the tributaries of the upper river bringing down nothing but cold spring water, keeping the temperature of the river below the normal for spawning purposes. Consequently, the shad ascended more than 300 miles. Mr Ford noticed that every pool in the upper river was full of shad, and he saw them playing in the water by hundreds. Mr Van Gordon saw them above Port Jervis, and they were observed as far up as Deposit N. Y.

The shad reaches a length of 2 feet. It is asserted that 50 years ago shad weighing from 8 to 13 pounds were not uncommon in the Susquehanna. It is said that even larger individuals were taken. In California the shad reaches a larger size than it does in the east, specimens weighing from 13 to 14 pounds being often seen in the markets. The average weight of females is 4 or 5 pounds. The male is much smaller.

The young shad remain in the rivers till the approach of cold weather, when they descend to the sea, and they are usually seen no more till they return as mature fish ready for reproduction. They are known to feed on small flies, crustaceans and insect larvae. They have been fed with fresh-water copepods and kept alive in this way till they had obtained a length of more than 1 inch. In the carp ponds, at Washington, Dr

Hessel succeeded in rearing shad on the Daphnia and Cyclops to a length of 3 or 4 inches, and one time, when they had access surreptitiously to an abundant supply of young carp, well fed individuals reached a length of 6 inches by the first of November. Shad have been kept at the central station of the U. S. Fish Commission over the winter, but at the age of one year, doubtless for lack of sufficient food, the largest was less than 4 inches long. At this age they were seen to capture smaller shad of the season of 1891, which were an inch or more in length. The commissioner of fisheries detected young shad also in the act of eating young California salmon; and on one occasion found an undigested minnow, 2 or 3 inches long, in the stomach of a large shad; and they have been caught with minnows for bait. The principal growth of the shad takes place at sea, and, when the species enters the fresh waters for the purpose of spawning, it ceases to feed, but will sometimes take the artificial fly and live minnows. The migratory habit of the shad has already been referred to. The spawning habits have been thus described by Marshall McDonald.

The favorite spawning grounds are on sandy flats bordering streams and on sand bars. The fish appear to associate in pairs, usually between sundown and 11 p. m. When in the act of spawning they swim close together near the surface, their dorsal fins projecting above the water and their movements producing a sound which the fishermen call "washing." The eggs are expressed by the female while in rapid motion; the male following close and ejecting his milt at the same time. Such of the eggs as come in contact with the milt are impregnated, but the greater portion of them are carried away by the current or destroyed by spawn-eating fishes. After impregnation the egg sinks to the bottom, and under favorable conditions develops in from three to eight days.

According to Seth Green, the embryo shad swim as soon as they break the shell, and make their way to the middle of the stream, where they are comparatively safe from predaceous fishes. A mature female shad of 4 or 5 pounds contains about 25,000 eggs on the average, but as many as 60,000 have been obtained from a 6 pound fish, and

100,000 were obtained from a single female on the Potomac. There is great mortality among the shad after spawning. Dead fish of both sexes are frequently seen floating in the water in the late months of summer.

Mitchill states that the shad visits New York annually about the end of March or beginning of April; that is, ascends toward the sources of the Hudson; that it usually weighs 4 or 5 pounds, but sometimes as much as 12 pounds. De Kay says a large variety, supposed to be an old fish, and weighing from 10 to 12 pounds, were frequently taken in the Hudson, under the name of yellow backs. The shad, in his time, ascended the river 150 miles, to spawn, and descended in the latter part of May. The introduction of gill nets, he writes, has caused a scarcity of the fish and will drive them from the river before many years.

Nets set off shore in Gravesend bay in the fall frequently inclose large quantities of young shad, sometimes a ton and a half at one time, during their migration seaward, but they are at once liberated. The fish are usually about 6 to 8 inches long. Oct. 17, 1895, 60 or 70 were caught in John B. De Nyse's pound, among them a male 11 inches long and 2⅞ inches deep, and a female 12 inches long and 3 inches deep. Oct. 31, 1895, a male 13½ inches long and 3½ inches deep, and a female 13½ inches long and 3⅝ inches deep were obtained in the same pound. Apparently the shad do not all remain at sea after their first migration till they are sexually mature. In the Potomac river young shad 8 to 9 inches long occasionally enter in the spring with the adults in large numbers. Mr De Nyse informs me that in the first spring run of small shad in Gravesend bay fully 90% are males.

Genus SARDINELLA Cuvier and Valenciennes

Small herrings of the tropical seas, with the vertebrae in reduced numbers, about 40 to 44, and with the scales large, usually firm and adherent, often crossed by vertical striae. Ventral scutes strong, 25 to 35 in number; adipose eyelid obsolete; lower jaw projecting, upper jaw somewhat emarginate, teeth weak; ventrals inserted behind front of dorsal; body compressed;

cheeks not deep; gill rakers long and numerous; otherwise essentially as in Pomolobus. The genus Sardinella, as here understood, covers a wide diversity of forms and may be divisible into several genera when the anatomy of the species is better known. (After Jordan and Evermann)

116 Sardinella species

Scaled Sardine

An individual about 9 inches long was obtained by W. I. De Nyse in Gravesend bay in 1895. This was the only one observed in that locality, and it is the only record known of the occurrence of a fish of this genus north of Florida. The specimen was seen and identified as a Sardinella by the writer, but, before he had opportunity to make a detailed study, it disappeared from the tank in which it was placed and could not be found.

Genus OPISTHONEMA Gill

Characters essentially those of Sardinella, except that the last ray of the dorsal is produced in a long filament as in Dorosoma, Megalops and Tarpon. Species few, American.

117 Opisthonema oglinum (Le Sueur)

Thread Herring; Shad Herring; Sprat Herring

Megalops oglina LE SUEUR, Jour. Ac. Nat. Sci. Phila. I, 359, Sept. 1818. Newport, R. I.

Megalops notata LE SUEUR, op. cit. 361, Sept. 1818. Guadeloupe.

Chatoessus signifer DE KAY, N. Y. Fauna, Fishes, 264, pl. 41, fig. 132, 1842.

Opisthonema oglina GOODE & BEAN, Proc. U. S. Nat. Mus. VIII, 206, June 8, 1885.

Opisthonema oglinum JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 432, 1896; BEAN, Bull. Amer. Mus. Nat. Hist. IX, 336, 1897; SMITH, Bull. U. S. F. C. XVII, 91, 1898.

Body oblong, deep, compressed, its greatest depth one third of the total length without caudal; caudal peduncle short, stout, its least depth one half the length of head; head short, deep, its length one fourth of total length without caudal; eye large, two sevenths to one third of length of head, slightly longer than snout; maxilla reaching to below front of pupil, its width more

than one half its length, the bone almost covering the mandible, which is scarcely projecting; gill rakers very long and slender; pseudobranchiae well developed; dorsal origin much nearer to tip of snout than to base of caudal, equidistant from snout and origin of anal, base of dorsal as long as the longest ray and two thirds as long as the head, filament reaching to base of caudal, much longer than the head in examples measuring from 7 to 9 inches; anal base as long as the head without the snout, its longest ray three fourths of diameter of eye; ventral origin under 8th or 9th developed ray of dorsal, the fin half as long as the head; pectoral four fifths as long as the head. Scales smooth, firm, but easily detached. Bluish above; lower parts silvery; an indistinct bluish spot behind the operculum; each scale on the back having a dark spot at its base, these forming streaks as in the glut herring. Length 12 inches. D. 19; A. 24. Scales 15-50; scutes 17 14. (West Indies, northward to Cape Cod in summer.)

The thread herring appears in July and August in Gravesend bay, and is sometimes so abundant as to fill the nets (fykes) of the fishermen. The great run begins toward the end of July and lasts two weeks. The fish is known there as the sprat herring.

De Kay, in *New York Fauna, Fishes*, p. 264, pl. 41, fig. 132, describes the species under the name Chatoëssus signifer. The colors, according to that author, are as follows: "Bluish above, with a series of dark points along the sides of the back, forming four or five longitudinal lines. A round black spot behind the upper part of the branchial aperture. Pectorals, ventrals and anal white. Dorsal and caudal yellow; the membrane finely punctate with black, and bordered with dusky. Irides white varied with yellowish." He further says: "It appears in our waters about the beginning of September, where it is often called the shad herring. It has also the names of thread herring and threadfish, in allusion to its last filamentous dorsal ray."

In the Woods Hole region of Cape Cod it is very rare, according to Dr Smith. A number were taken in the fall of 1871. In 1885 it was common in Buzzards bay and Vineyard sound in July. It remained about a month, and specimens were taken in traps at almost every lift. During the next four years the fish was also noticed, but none has been seen since 1890.

Genus BREVOORTIA Gill

Body elliptic, compressed, deepest anteriorly, tapering behind; head very large; cheeks deeper than long; mouth large, the lower jaw included; no teeth; gill rakers very long and slender, densely set, appearing to fill the mouth when it is opened; gill arches angularly bent. Scales deeper than long, closely imbricated, their exposed edges vertical and fluted or pectinated. Dorsal fin low, rather posterior; anal fin small. Intestinal canal elongate. Vertebrae 48. Peritoneum dusky. Species few; inhabiting the Atlantic; spawning probably in brackish water in the spring. Coarse, herbivorous fishes, not valued as food, but the young of the greatest value as food to other fishes. (After Jordan and Evermann)

118 Brevoortia tyrannus (Latrobe)

Menhaden; Mossbunker

Clupea tyrannus LATROBE, Trans. Am. Phil. Soc. Phila. V, 77, pl. 1, 1802. (Chesapeake bay)

Clupea menhaden MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 453, pl. V, fig. 7, 1815, New York; GÜNTHER, Cat. Fish. Brit. Mus. VII, 436, 1868.

Alosa menhaden DE KAY, N. Y. Fauna, Fishes, 259, pl. 21, fig. 60, 1842; STORER, Hist. Fish. Mass. 158, pl. XXVI, fig. 4, 1867.

Brevoortia tyrannus GOODE, Proc. U. S. Nat. Mus. I, 531, 1878; Fish & Fish. Ind. U. S. I, 569, pl. 205, 1884; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 269, 1883; BEAN, 19th Rep. Comm. Fish. N. Y. separate, 44, pl. XXV, fig. 35, 1890; Bull. Amer. Mus. Nat. Hist. IX, 336, 1897; 52d Ann. Rep. N. Y. State Mus. 96, 1900; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 433, 1896, pl. LXXIII, fig. 195, 1900; SMITH, Bull. U. S. F. C. XVII, 91, 1898.

The menhaden has the exposed surfaces of its scales very narrow and deep. The body is similar in shape to that of the shad, the depth being one third of the length without caudal, and somewhat greater than the length of the head. Mouth large; jaws toothless. The maxilla extends to below the hind

margin of the eye. The eye is about as long as the snout, one fifth of length of head. The fins are small, the pectoral not much more than half the length of the head and twice as long as the ventral. The dorsal base is equal in length to the pectoral; longest dorsal ray more than twice as long as the last ray and about two fifths of length of head. The anal rays are shorter than those of the dorsal; length of anal base little more than one half the length of head. The origin of the dorsal is about midway between tip of snout and end of middle caudal rays. The sides and fins are silvery, yellowish, the upper parts bluish. Behind the head there is a large dark spot, larger than the pupil, and behind it numerous smaller dark spots.

The menhaden has received more than 30 common names, among which the one here employed is the best known and most suitable. In New Jersey it is frequently called bunker or mossbunker, and in some other localities it is the bony fish. It is also called bugfish, because of a crustacean parasite which is found in the mouth.

The menhaden reaches a length of 15 inches or more; its average size is about 1 foot. It is found along our east coast from Maine to Florida, swimming in immense schools and fluctuating greatly in abundance. In certain localities its movements are affected chiefly by temperature.

The use of the menhaden as a source of oil and a material for fertilizers is so well known as scarcely to need mention here. As an edible fish it is not generally esteemed; in most localities it is seldom eaten, though in some places it is considered a good food fish. Since the mackerel is becoming scarce, menhaden are often salted in barrels as a substitute for that fish.

The menhaden appears in Dr Mitchill's *Fishes of New York* as the bony fish, hardhead or marshbanker. The aboriginal name menhaden, and the one most suitable for the species, is mentioned by this writer. Dr De Kay, in his *New York Fauna*, introduced the name mossbunker as well as the Indian names *panhagen* and *menhaden*. He notes also the names skippang and bunker as in use at the east end of Long Island. For a survey

of the 30 or more additional appellations of this well known fish, the reader is referred to the complete history of the American menhaden by Dr G. Brown Goode.

The menhaden comes into Gravesend bay in May and through the summer. Occasional individuals are seen there in the fall as late as November. The fish can be kept alive in the winter in captivity, provided the water temperature does not fall below 50° F. It makes its appearance on the shores of Long Island about the beginning of June, sometimes in May, and remains till the cold season sets in. A few specimens were taken September 22 in Blue Point cove in 1884, and Oct. 1, 1890, many thousands were caught in a trap at Islip; these were large and very fat fish. The use of the menhaden as a bait fish is too well known to need special mention. In "chumming" for bluefish near Fire island inlet this is the favorite bait. In 1898 the young were obtained at Duncan's creek, Howell's point and Nichols's point August 29. Adults were sent from Islip by W. F. Clark August 18.

In the vicinity of Woods Hole Mass., according to Dr Smith, menhaden arrive in schools about May 20, but scattered fish are taken in March with alewives; they remain till December 1, sometimes till December 20, but are most abundant in June. When the schools first arrive, the reproductive organs of many of the fish are in an advanced stage of development, but after July 1 none with large ovaries are found. Late in fall the fish again have well developed roes. The smallest fish are about an inch long; these are found in little schools about the shores and wharves as early as July 15. The young are abundant throughout summer and fall. The average length of adults is 13 or 14 inches; one fish 18 inches long was caught at Woods Hole in 1876.

Family ENGRAULIDIDAE

Anchovies

Genus STOLEPHORUS Lacépède

Body oblong, compressed, covered with rather large, thin, deciduous scales; belly rounded, or weakly compressed; snout conical, compressed, projecting beyond the very large mouth;

maxillary narrow, little movable, usually formed of three pieces, extending backward far behind the eye, to the base of the mandible, or beyond, not beyond gill opening; premaxillaries very small; teeth small, subequal, present at all ages, usually on the jaws, vomer, palatines, and pterygoids. Anal fin moderate, free from caudal (its rays 12 to 40); no pectoral filaments; dorsal inserted about midway of body, posterior to ventrals; pectorals and ventrals each with a large axillary scale. Adipose eyelid obsolete. Vertebrae about 40 (40 to 42) in species examined. Flesh rather pale and dry, more or less translucent, the bones firm. Pseudobranchiae present; branchiostegals nine to 14; gill rakers long and slender; gill membranes separate, free from the narrow isthmus.

119 Stolephorus brownii (Gmelin)

Striped Anchovy

Atherina brownii GMELIN, Syst. Nat. I, 1397, 1788.

Clupea vittata MITCHILL, Trans. Lit. & Phil. Soc. N.Y. I, 456, 1815; DE KAY, N. Y. Fauna, Fishes, 254, 1842.

Engraulis vittata BAIRD, 9th Ann. Rep. Smith. Inst. 347, 1855.

Engraulis brownii GÜNTHER, Cat. Fish. Brit. Mus. VII, 389, 1868.

Stolephorus brownii JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 273, 1883; BEAN, Bull. U. S. F. C. VII, 149, 1888; 19th Rep. Comm. Fish. N. Y. 279, 1890.

Stolephorus brownii JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 443, 1896; SMITH, Bull. U. S. F. C. XVII, 92, 1898; BEAN, 52d Ann. Rep't N. Y. State Mus. 97, 1900.

Body moderately elongate, compressed, but thicker than in S. mitchilli, its greatest depth two ninths of the total length without caudal, and equal to length of head without the snout, the thickness one half length of head; head moderate, its length rather more than one fourth of total without caudal, the snout short and obtusely pointed, one fifth of length of head, two thirds of length of eye; eye equal to width of interorbital space, about two sevenths as long as the head. The maxilla reaches as far back as the mandible, but not to hind edge of opercle. The mandible is partly covered by the maxilla, its tip in advance of the front of eye and overhung by the snout. Teeth moderately strong, those on the posterior part of the maxilla

raking forward. Gill rakers rather long and slender, numerous, the longest on first arch three fourths as long as the eye. Origin of dorsal fin midway between base of caudal and front of eye, its length of base four sevenths of length of head, its longest ray one half as long as the head, a sheath of scales at base; anal with a strong sheath of scales, its base as long as the head without the snout; ventrals small, originating in advance of dorsal origin, the length equal to eye; axillary scale of pectoral one half as long as the head. Width of silvery band one fourth the length of head. D. 14 to 15; A. 20. Scales 40 to 42. Upper parts light brown; sides silvery; a broad, bright silvery lateral stripe. Length sometimes above 6 inches. Here described from an example taken at Lifesaving station no. 22, Long Island, and now in the U. S. National Museum.

The species occurs from Cape Cod southward to Brazil and the West Indies.

This is the satin striped herring of Mitchill's *Fishes of New York*, p. 456. By some of the fishermen in Great South bay it is supposed to be the whitebait and is so called. The anchovy was extremely abundant in the bay in September 1884. I found it at the mouth of Swan creek, in Blue Point cove, near the Lifesaving station, at Oak island and at Fire island. Specimens were seen as late as October 7.

This anchovy forms a very important part of the food of the young weakfish and bluefish in Great South bay. It is present in very large numbers and could be utilized as a food species. The largest examples of this fish which we have seen were taken in Great Egg Harbor bay in August; individuals measuring 5½ inches in length were taken in the surf by hundreds, and weakfish were feeding on them ravenously. In two hauls of a 20 fathom seine we took here 54 weakfish.

This species was not common in Great South bay during the summer of 1898. It was found at Blue Point cove August 18, and young were obtained at Nichols's point September 1.

Dr Smith records it as usually abundant at Woods Hole, occasionally rather uncommon. Found from August to late in fall. More numerous than any other anchovy.

120 Stolephorus argyrophanus (Cuv. & Val.)

Silvery Anchovy

Engraulis argyrophanus Cuvier & Valenciennes, Hist. Nat. Poiss. XXI, 49, 1848.

Stolephorus perfasciatus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 273, 1882, not *Engraulis perfasciatus* Poey, Mem. Cuba, II, 312, 1858.

Stolephorus crystole Swain & Meek, Proc. Ac. Nat. Sci. Phila. 34, 1884; Bean, Bull. U. S. F. C. VII, 150, pl. III, fig. 19, 1888.

Stolephorus argyrophanus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 444, 1896; Bean, Bull. Amer. Mus. Nat. Hist. 337, 1897; Smith, Bull. U. S. F. C. XVII, 92, 1898.

Body elongate, much more slender than in S. b r o w n i i, and not so much compressed; head not so deep as in S. b r o w n i i, more pointed, the snout rather sharp; eye rather small, four and one half in head, not larger than snout; maxillary teeth well developed, mandibulary teeth very slender; gill rakers very long, as long as the eye; maxillary shorter than in S. b r o w n i, not reaching quite to the base of the mandible; belly slightly compressed, not serrated. Scales very deciduous. Ventrals short, very slightly in front of dorsal; caudal peduncle long and slender; dorsal inserted scarcely nearer caudal than snout. Silvery stripe broad, half wider than the eye, bordered above by a dusky streak. Head three and four fifths; depth 6. D. 12; A. 20. Length 4 inches. West Indies; occasional northward. A specimen in our collection from Woods Hole Mass. (After Jordan and Gilbert)

The types of this species were obtained by Kuhl and Van Hasselt in the equatorial Atlantic. Cuvier and Valenciennes, in their original description[1] of the fish, contrast it with S. b r o w n i and others, from which it is distinguished by its form and by other characters.

It has the body longer and slenderer; the cleft of the mouth more oblique; the pectoral and anal much shorter; the teeth excessively small. B. 11; D. 15; A. 17. The color is blue, more pronounced on the back than on the belly. A silvery band running along the sides. *Cuvier and Valenciennes*

Young individuals were seined at Ocean City N. J. Aug. 1, 1887; again at Longport N. J. numerous young were taken Aug.

[1] Hist. Nat. Poiss. 1848. 21:49.

29, 1887; no adults were seen. A figure of the young is published by Dr Bean in bulletin for 1889 of the U. S. Fish Commission, vol. 7, pl. 3, fig. 19. The example figured was nearly 1½ inches long. It has the following characters: The hight of the body is one sixth of the total length without caudal; least hight of caudal peduncle one third of length of head. Head rather large, two sevenths of total length without caudal, with obtusely pointed snout which is about equal to the eye and one fourth as long as the head. The maxilla does not reach to the hind edge of the preopercle. Dorsal origin nearer to caudal base than to tip of snout; the base of the fin as long as the longest ray and one half as long as the head. Pectoral short, three sevenths as long as the head; ventrals in advance of dorsal, under the 16th row of scales, the length two fifths of length of head; anal origin under the end of the dorsal, anal base about two thirds as long as the head and one fifth of total length without caudal; longest anal ray one half as long as the head; caudal fin large and deeply forked. D. ii, 19; A. ii, 18. Scales 8–78.

Many individuals were collected at Fire island near the end of September. None were seen in other parts of the bay. The species is known there as whitebait, like the other anchovies. In Gravesend bay the species is not common, but it occurs more frequently in bays communicating directly with the Atlantic.

121 Stolephorus perfasciatus (Poey)

Banded Anchovy

Engraulis perfasciatus Poey, Mem. Cuba, II, 312, 1858; Gunther, Cat. Fish. Brit. Mus. VII, 391, 1868.

Stolephorus perfasciatus Swain & Meek, Proc. Ac. Nat. Sci. Phila. 34, 1884; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 441, 1896.

Body elongate and not much compressed, its greatest hight about one sixth of total length without caudal and two thirds of length of head, its greatest thickness more than one third of length of head; least hight of caudal peduncle equal to thickness of body behind the head; head long, with pointed snout, one fourth of total without caudal, snout equal to eye and two ninths of length of head. The maxilla extends backward to

front edge of preopercle and not to joint of mandible. Interorbital space equal to eye; gill rakers numerous, about as long as the eye; teeth minute and weak, nearly uniform in size. Dorsal origin about midway between tip of snout and base of caudal, dorsal base short, scarcely more than one half as long as head, and about equal to longest dorsal ray; ventrals little in advance of dorsal origin, very short, only two fifths of length of head; pectoral moderate, equal to postorbital part of head. Axillary scale very slender, less than one half as long as the head. Width of silvery band about equal to length of eye. D. ii, 12; A. i, 15 to 16. Scales 44 to 45. Here described from specimens obtained at Noank Ct. and in Gravesend bay, L. I., the largest about 3 inches long.

Upper parts light brown, sides silvery; dark punctulations on base of caudal and sometimes on anal; belly even in alcoholic specimens with iridescent colors.

The example obtained in Gravesend bay was collected by W. I. De Nyse. It has D. 12; A. 15 or 16; scales 45.

The close resemblance of this species to S. argyrophanus Cuv. & Val. makes a farther comparison of the two necessary. Perhaps, as long ago suggested by Dr Günther,[1] the two are identical. S. argyrophanus was collected in the equatorial Atlantic, and Poey's species, perfasciatus, is from Cuba and Porto Rico. There seems to be little to distinguish them except the slightly greater number of anal rays in S. argyrophanus, and these have been counted differently by different students; the authors, for example, discovered 17, while Dr Jordan found 19 in the same type.

122 Stolephorus mitchilli (Cuv. & Val.)

Anchovy; Whitebait

Engraulis mitchilli Cuvier & Valenciennes, Hist. Nat. Poiss. XXI, 50, 1848. New York; Carolina; New Orleans.

Stolephorus mitchilli Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 248, 1883; Jordan, Cat. Fish. N. A. 38, 1885 (name only); Bean, Bull. U. S. F. C. VII, 149, 1888; 52d Ann. Rep. N. Y. State Mus. 97, 1900; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 446, 1896; Smith, Bull. U. S. F. C. XVII, 92, 1898.

[1] Cat. Fish. Brit. Mus. 1868. 7:391.

Engraulis rittatus STORER, Hist. Fish. Mass. pl. XXVII, fig. 3, not description on page 163.

Body compressed, short and deep, its greatest depth one fourth of the total length without caudal, caudal peduncle short and deep, its least depth one half the length of head. Thickness of body equals three sevenths of length of head. Head rather short, its length two ninths of total without caudal. Snout shorter than eye, which is two sevenths as long as the head. The maxilla extends slightly beyond the hind end of mandible, and nearly to the edge of operculum. Interorbital distance not quite equal to eye. Gill rakers nearly as long as the eye. Origin of dorsal fin much nearer to base of caudal than to tip of snout. Length of dorsal base equals two thirds of length of head; longest dorsal ray one half as long as head. Anal origin under the middle of dorsal; length of anal base equals two sevenths of total length without caudal; longest anal ray about two thirds as long as the head. Ventral short, in advance of dorsal, its length one third of length of head. Pectoral one eighth of total length without caudal. Width of silvery band about two thirds of eye. Dorsal and anal scaly sheaths very strong. D. ii, 10; A. 28; V. i, 6. Scales 37. Length of specimens examined, 4 inches. Taken at Fire island.

Cape Cod to Texas, on sandy shores; the most abundant of the New York species. It enters Gravesend bay in May and remains till October. Locally known as anchovy and whitebait. An excellent food fish and very important as the food of larger fishes.

It is very generally distributed in bays along the south shore of Long Island, having been found abundant in Scallop pond, Peconic bay, in Mecox bay, and almost everywhere in Great South bay from July to September 1898. A specimen taken at Fire island had a lernaean parasite attached to it. At Woods Hole Mass. Dr Smith reports it abundant, associated with S. b r o w n i i .

Family SALMONIDAE

Salmons

The whitefishes of New York belong to seven species, representing the four divisions of the genus C o r e g o n u s . In two

of the species the lower jaw is included within the upper, the mouth is small, and the intermaxillary bone broad and more or less vertical in position. These two may be readily distinguished by the structure of the gill rakers, and the size of the mouth. The remaining five whitefishes have the lower jaw as long as, or longer than, the upper, the mouth large, and the intermaxillary narrow and not vertical in position. They are easily separated from one another by the shape of the body, and the size and contour of the scales. The relations of the groups are shown in the following key.

1 Lower jaw shorter than upper.

1*a* Mouth very small, upper jaw not reaching to eye; gill rakers short and stout, 13 to 16 below angle of first arch (Prosopium)

QUADRILATERALIS

1*b* Mouth moderate, upper jaw reaching beyond front of eye; gill rakers long and slender, 20 or more below angle of first arch (Coregonus)

CLUPEIFORMIS

2 Lower jaw equal to or longer than upper.

2*a* Body slender, elongate; scales small, and convex on their free margin; lower jaw longer than upper (Argyrosomus)

OSMERIFORMIS ARTEDI, HOYI

PROGNATHUS

2*b* Body deep, short; scales large, deep, the free margin scarcely convex; jaws equal (Allosomus)

TULLIBEE

Genus COREGONUS (Artedi) Linnaeus

Body oblong or elongate, compressed; head more or less conical, compressed, the snout more or less projecting beyond the lower jaw; mouth small, the maxillary short, not extending beyond the orbit, with a well developed supplemental bone; teeth extremely minute, if present; scales moderate, thin, cycloid, rather firm. Dorsal fin moderate; caudal fin deeply forked; anal fin somewhat elongate; ventrals well developed. Pseudobranchiae large; gill rakers varying from short and thickish to long and slender; air bladder very large; vertebrae 56 to 60; stomach horseshoe-shaped, with many (about 100) pyloric caeca; ova small. Species about 15, inhabiting the clear lakes of northern Europe, Asia, and America, in arctic regions descending to the sea. Most of them spawn in late fall or

winter near the shore, at other seasons often frequenting considerable depths.

123 Coregonus quadrilateralis Richardson

Round Whitefish; Frostfish

Coregonus quadrilateralis Richardson, Franklin's Journ. 714, 1823. Fort Enterprise, British America; Agassiz, Lake Superior, 351, 1850; Günther, Cat. Fish. Brit. Mus. VI, 176, 1866; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 298, 1883; Bean, Fishes Penna. 66, pl. 26, fig. 47, 1893; Bull. Amer. Mus. Nat. Hist. IX, 337, 1897; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 465, 1896.

Salmo (Coregonus) quadrilateralis Richardson, Fauna Bor.-Amer. III, 204, pl. 89, fig. 1, 1836. Great Bear Lake.

Coregonus novae angliae Prescott, Amer. Jour. Sci. Arts, XI, 342, 1851. Lake Winipiseogee, N. H.

Coregonus novae angliae Günther, Cat. Fish. Brit. Mus. VI, 186, 1866.

This is a small species and very readily distinguished from all other American species except Williamson's whitefish by its diminutive mouth. The body is slender, elongate, subterete, its greatest depth slightly exceeding one fifth of total length to base of caudal. The head is long, its length one fifth of total without caudal, and the snout is thin and obtuse at tip. The broad maxilla does not reach to below the front of the eye, its length less than one fifth of length of head. D. 11; A. 10. Scales in lateral line, 80 to 90. Upper parts dark bluish; sides silvery.

This species is called frostfish in the Adirondacks; other names are Menominee whitefish, roundfish, shad-waiter, pilotfish and chivey, the last term applied to the fish in Maine.

The roundfish is found in lakes of New England, sometimes running into streams, the Adirondack region of New York, the Great lakes and northward into British America and Alaska. Its distribution has been extended by transplanting on account of its great value as food for the lake trout and other large fish of the salmon family. It seldom exceeds a length of 12 inches and a weight of 1 pound. Like some other species of whitefish, it spawns in shallow parts of lakes or ascends their small tributary streams for that purpose. The food consists of small

shells and crustaceans. The species frequents deep waters, where it falls an easy prey to the voracious lake trout.

The roundfish is excellent for the table. Its capture with hook and line is difficult because of its very small mouth and its habit of retiring into deep water. In the Great lakes it does not constitute an important element of the fishery, but in northern regions it is one of the most useful and highly prized of the food fishes.

This small whitefish is one of the characteristic species of the Adirondack lakes. James Annin jr sent specimens for identification from Hoel pond and Big Clear lake, in Franklin county, N. Y., and from the third lake of the Fulton Chain. He states that the fish spawns in the little inlets or on the sand beaches. It never appears till about the time the water begins to chill and freeze about the edges. On the Fulton Chain of lakes the spawning season of 1895 was practically closed about November 20.

The frostfish, according to Mr Annin, is "a delicious morsel."

The following notes were made on fresh examples received from the third lake of the Fulton Chain Nov. 26, 1895.

A male 11⅜ inches long to end of caudal fin had the middle caudal rays, from end of scales, ⅝ inches long; upper caudal lobe, measured horizontally, 1⅝ inches; head, 1 3/16 inches; maxilla, ⅜ inch; eye, ⅜ inch; gill rakers, 5 + 10; the longest ¾ as long as the eye; scales, 8–84 8. A female 11⅝ inches to tip of caudal has upper caudal lobe 2 inches, measured horizontally; middle caudal rays from end of scales, 1 5/16 inch; depth of body, 2¼ inches; head, 1⅝ inches; maxilla and eye, each ⅜ inch; gill rakers, 5 + 10, the longest ¼ as long as the eye; scales, 8–79–8.

Three males received Dec. 11, 1895, showed the following colors.

In the male, 13⅜ inches long, from Hoel pond, the back and sides were dark steel gray; the belly white; pectoral, ventral and anal orange; dorsal and caudal chiefly yellow. A male 12 inches long, from Big Clear lake, had the back and sides silvery gray, darker between the lines of scales; the lower fins orange; the dorsal and caudal with traces of yellow. A male 11⅛ inches

long, from Big Clear lake, showed the same colors as the last. The following measurements in inches and notes were taken.

	Hoel pond	Big Clear lake	Big Clear lake
	♂	♀	♀
Length	13⅜	12	11⅛
Caudal lobe, horizontally	2	1⅞	1⅞
Middle caudal rays	¾	⅝	[illegible]
Depth of body	2½	2⅜	2 [illegible]
Least depth of caudal peduncle	⅞	¾	[illegible]
Head	2	1¾	1⅝
Snout	½	....	....
Eye	[illegible]	[illegible]	⅜
Maxilla	[illegible]	⅜	⅜

In all, the gill rakers are minute, and number: 5 + 10, 5 + 10 and 5 + 9. The scales are: 10–86–9, 10–76–9, and 9–86–8.

An example sent by the New York Commission of Fisheries, Game and Forest, from Saranac Lake, Nov. 23, 1897, showed the following characters.

MEASUREMENTS

	Inches
Length, including caudal	13
Length to end of scales	11½
Length of middle caudal rays (from end of scales)	⅞
Length of upper caudal lobe (obliquely)	2⅛
Depth of body at dorsal	2⅜
Least depth of caudal peduncle	[illegible]
Length of head	2⅛
Diameter of eye	[illegible]
Length of maxilla (does not reach orbit)	[illegible]
Length of mandible	¾
Distance from snout to dorsal origin	5⅛
Length of dorsal base	1[illegible]
Length of longest dorsal ray	1⅝
Length of last dorsal ray	[illegible]
Distance from snout to ventral origin	5⅝
Length of ventral	1[illegible]
Length of ventral appendage	½
Distance from snout to anal origin	8¾
Length of anal base	1[illegible]
Length of longest anal ray	1[illegible]
Length of last anal ray	½
Length of pectoral	2
Distance from snout to adipose fin	9¼
Length of base of adipose fin	[illegible]
Width of adipose fin	⅜
Length of adipose fin	⅜
Length of longest gill raker	⅛

D. 11; A. 11; V. i, 10; P. i, 14. Scales, 10-84-8. Gill rakers, 6 + 10, the longest $\frac{1}{2}$ inch.

Purplish gray; lower parts whitish; pectorals, ventrals and anal vermilion; eye pale golden; head, specially behind the eyes, with iridescent gold and purple tints; caudal, chiefly vermilion in life.

The fish is a male with ripe milt. There are numerous small tubercles on the scales of the sides above and below the lateral line.

124 Coregonus clupeiformis (Mitchill)

Common Whitefish; Labrador Whitefish; Shadwaiter

Salmo clupeiformis Mitchill, Amer. Month. Mag. II, 321, March, 1818. Lake Huron; Cayuga Lake.

Coregonus albus Le Sueur, Jour. Ac. Nat. Sci. Phila. I, 232, May, 1818. Lake Erie; Thompson, Nat. Hist. Vermont, I, 143, figure, 1842; Kirtland, Bost. Jour. Nat. Hist. III, 477, pl. XXVIII, fig. 3, 1841; De Kay, N. Y. Fauna, Fishes, 247, pl. 76, fig. 240, 1842; Gunther, Cat. Fish. Brit. Mus. VI, 184, 1866.

Salmo (Coregonus) labradoricus Richardson, Fauna Bor.-Amer. III, 296, 1836.

Coregonus sapidissimus Agassiz, Lake Superior, 344, 1850.

Coregonus latior Agassiz, op. cit. 348, 1850.

Coregonus clupeiformis Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 299, 1883; Goode, Amer. Fishes, 489, figure, 1888; Bean, Fishes Penna. 67, color pl. 3, 1893; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 465, 1896, pl. LXXVI, fig. 202, 1900; Cheney, Third Ann. Rept. N. Y. Comm. Fish. color pl. facing p. 190, 1898.

Coregonus labradoricus Gunther, Cat. Fish. Brit. Mus. VI, 176, 1866, and of authors generally.

The common whitefish of the Great lakes is so well known that it scarcely needs an elaborate description. The body is stout and deep, its depth at the nape greatly increased in adults. The greatest depth is two sevenths of the total length to caudal base. Caudal peduncle short, its depth one half the length of head, which is about one fifth of total without caudal. The snout is sharp, conical, two sevenths as long as the head and about twice as long as the eye. The maxilla reaches to below front of eye. The dorsal origin is above the 23d scale of the lateral line, and the ventral begins under the middle of the dorsal. The longest dorsal ray equals length of head without snout, adipose fin stout and low. The dorsal and anal bases

are equal to each other and two thirds of length of head. D. 10 divided rays; A. 11 divided rays; V. 11; P. 15. Scales in lateral line 74 to 80. The upper parts are grayish or light olive in color; the sides white and lustrous in life.

Names. The name whitefish is thoroughly identified with this species and is seldom varied except by means of the prefix "common" or "lake." A well marked variety in Otsego lake, N. Y., has long been known as the Otsego bass.

Distribution. The common whitefish occurs in the Great lakes and northward into British America; its northern limit is not definitely known. In Alaska, where the species was formerly supposed to exist, it is replaced by a similar, but well marked form, the Coregonus richardsoni of Günther. The variety known as Otsego bass is found in Otsego lake. If we may judge from the yield of the fisheries, Lake Michigan has more whitefish than any of the other lakes; Superior ranks second; Erie third; Huron fourth; and Ontario is sadly in the rear.

Size. The largest individual on record was taken at Whitefish Point, Lake Superior; it weighed 23 pounds. A 17 pound specimen was caught at Vermilion, in Lake Erie in 1876. The size varies greatly with locality, ranging in general all the way from $1\frac{3}{4}$ pounds to 14 pounds. In Lake Erie in 1885 the average weight was between 2 and 3 pounds. The length of adults will average 20 inches.

Habits. There is a movement of the whitefish in many lakes from the deep water early in the summer into the shoal water near the shore. In the midsummer, however, the usual retreat of this species is the deep and cold parts of the lakes which they inhabit. Again, as the spawning season approaches in October, the whitefish come toward the shore to deposit their eggs. It is said that they do not spawn till the water has reached a temperature of about 40°. After spawning they again retire to deep water, where they remain during the winter. Mr Milner observed that the shoreward migration varies with locality, and is influenced also by depth of water and temperature. In Lake Erie, for example, which has a high summer temperature, there

is no shoreward migration in summer. It is to be noted also that the whitefish moves along the shore, and in some cases it ascends rivers for the purpose of spawning. It is believed also that when the feeding grounds of the whitefish are polluted by mud, the fish temporarily seek other localities. There appears to be a spring and summer migration likewise from lake to lake. Spawning takes place during October, November and December, on shoals or occasionally in rivers. The female is larger than the male. According to the observations of George Clark, the two sexes, in the act of spawning, frequently throw themselves together above the surface, emitting the spawn or milt with the vents close together. Spawning operations are most active in the evening, are continued at night, and the eggs are deposited in lots of several hundred at a time. The number of eggs in a fish of 7½ pounds was 66,306; the average number being nearly 10,000 for each pound of the female's weight. The period of incubation depends on the temperature. The usual time of distribution of the young is in March and April. The very young are described as swimming near the surface and not in schools. They are very active and soon seek deep water to escape from their enemies. Their food consists chiefly of small crustaceans. The adults subsist on the same food with the addition of small mollusks.

Growth. The only means of determining the rate of growth of the whitefish is by artificial rearing. Samuel Wilmot had young fish which were 5 inches long at the age of four months. The growth under natural conditions must be even greater than this. Mr Wilmot, himself, has seen whitefish measuring 7 inches in December in his ponds.

Enemies and diseases. The eggs of the whitefish are destroyed in immense numbers by the lake herring, Coregonus artedi. The water lizard, Menobranchus, also consumes vast numbers of the eggs. The young whitefish are eaten extensively by the pike perch, black bass, pike, pickerel and freshwater ling. The lake trout also feed on the whitefish. A leach parasitic on the whitefish proves very troublesome to that spe-

cies, and the scales are liable to a peculiar roughness which has been observed late in November or during the spawning season. There is also a lernean which fastens itself to the gills and other parts of the whitefish.

Uses and capture. The excellence of the flesh of the whitefish is so well known as scarcely to require mention. Its commercial value is great. In Lake Erie in 1885, according to statistics collected by the U. S. Fish Commission, 3,500,000 pounds of whitefish were caught, more than 2,000,000 of this amount by fishermen from Erie alone. In this year Erie county had 310 persons employed in the fisheries. The capital invested in the business was nearly $250,000. The wholesale value of the fish products was upward of $400,000. The whitefish was the third species in relative importance, blue pike ranking first and the lake herring second. In Erie county whitefish are caught chiefly in July, August and November, and the bulk of them are taken in gill nets. Pound nets are also employed in the capture of whitefish.

Artificial propagation. Carl Müller of New York and Henry Brown of New Haven are credited with the first attempt to propagate the whitefish artificially. Their experiments were made in Lake Saltonstall, near the city of New Haven. The result of the experiments, which were repeated in 1858, is not known. In 1868 Seth Green and Samuel Wilmot began a series of experiments in the same direction, and in 1869 N. W. Clark, of Clarkson Mich. took up the same work. In 1870 a half million eggs were placed in hatching boxes by Mr Clark. In 1872, through the aid of the U. S. Fish Commission, Mr. Clark's hatching house was doubled in capacity, and a million eggs were taken from Lake Michigan. Since that time both the national and state governments have made the whitefish the object of their most extensive operations.

Dr Meek saw no specimens of whitefish from Cayuga lake, but he thinks it is an inhabitant. The U. S. Fish Commission obtained a specimen at Cape Vincent N. Y. Nov. 17, 1891.

A young individual was received from Wilson, Niagara co. N. Y.; caught in a gill net in Lake Ontario and sent by James Annin jr.

A male and a female were received through James Annin jr from Upper Saranac lake Nov. 16, 1895. Both fish were nearly spent. They were believed to be the common whitefish. A male from Chazy lake arrived through the same source Nov. 22, 1895. It was doubtfully called "blackfin whitefish." At that time the fish had left the spawning beds and were in deep water. June 17, 1896, a female 19½ inches long was shipped by Mr Annin from Canandaigua lake. Its stomach is pear-shaped with walls more than ¼ inch thick; it contained numerous small shells of several genera, not yet identified.

The species is reported by fishermen to be very abundant in that lake, and to be destructive of eggs of other fish. They say it comes in great numbers into shallow water near the shore in early summer when the water is roily, and can be caught on set lines. Mr Annin saw men baiting their set lines with small minnows on Canandaigua lake, and, when the lines were taken up in the morning, the whitefish was found on the hooks. It is said that one so taken weighed 6 pounds. Sup't O. H. Daniels, of the New Hampshire fish commission, forwarded a specimen from Lake Winnesquam, at Laconia, 19¾ inches long, weighing 46 ounces, and he wrote that individuals weighing 7½ pounds had recently been taken. The species was called "bluefin" and whitefish.

The fish-eating habit of the whitefish was fully verified in the aquarium on examples obtained in Canandaigua lake in November 1896, by Mr Annin. Knowing that the species usually subsists on small mollusks and crustaceans, efforts were made to provide the fish with Physa and Gammarus; but this became difficult in winter, and an experiment was made with small killifish (Fundulus heteroclitus and majalis), which proved satisfactory during the cold months. In summer, however, it was found necessary to return to the use of Gammarus. The whitefish at first took the killifish without any eagerness, but they soon learned to chase their prey and take it much as trout do.

A female received from Canandaigua lake June 17, 1896, in a fresh state, showed the following colors: membrane of pectoral

fins dusky; that of the pectorals tinged with lemon yellow; ventrals dusky at the tip; anal pale; caudal pale except a narrow dusky portion of the middle rays; eyes pearly with golden iridescence. The maxilla reaches about to front of eye. The adipose dorsal extends straight backward, and its base is covered with a sheath of small scales $\frac{2}{10}$ of an inch wide. The gill rakers are 9 + 17, the longest $\frac{3}{8}$ of an inch. Very small teeth are present on the tongue. The eggs are minute.

In a male example, 17¼ inches long, received Nov. 16, 1895, from Upper Saranac lake and nearly spent, no tubercles could be seen on the scales; but several of the males from Canandaigua lake had them well developed. There is a great difference in the development of the lingual teeth, some of our individuals showing only a trace of them, and it seems as if there may be some relation between their condition and the sexual maturity of the fish. For example, in a male 14 inches long, sent from the fourth lake of the Fulton Chain Nov. 9, 1897, the lingual teeth were present in a large patch; in three males, only a little smaller but sexually immature, from Saranac lake Nov. 11, 1897, the teeth on the tongue could be perceived by the touch only. The following measurements, in inches, and additional notes, were made from the fresh fish.

MEASUREMENTS

	Canandaigua lake, June 17, 1896 ♀	Upper Saranac, Nov. 16, 1895 ♂	Chazy lake, Nov. 22, 1895 ♂
Length, including caudal	19⅝	17¼	15½
Length of middle caudal rays (from end of scales)	1	⅛	⅞
Length of upper caudal lobe (horizontally)	3	3½	....
Length of longest caudal ray	3¼	....	....
Depth of body at dorsal	4¾	3½	....
Least depth of caudal peduncle	1½	....	1⅛
Length of head	3⅜	2¾	2½
Diameter of eye	⅝	⅝	½
Length of maxilla	1	¾	⅝
Distance from snout to dorsal origin	8	....	....
Length of dorsal base	2⅛	....	....
Length of longest dorsal ray	2½	....	....

MEASUREMENTS

	Canandaigua lake, June 17, 1896	Upper Saranac, Nov. 16, 1896	Chazy lake, Nov. 22, 1896
	♀	♂	♀
Length of last dorsal ray	¾	....	....
Distance from snout to ventral origin	9	....	....
Length of ventral	2¾	....	....
Length of ventral appendage	⅞	....	....
Distance from snout to anal origin	13	....	....
Length of anal base	2	....	....
Length of longest anal ray	1¾	....	....
Length of last anal ray	⅝	....	....
Length of pectoral	3	....	....
Distance from snout to adipose fin	14	....	....
Length of base of adipose fin	1	....	....
Length of adipose fin	¾	....	....
Width of base of adipose fin	½	....	....
Length of longest gill raker	⅜	⅜	⅜

Taking the fish in the order above given, the gill rakers are: 9 + 17, 10 + 16, and 9 + 17. The scales are: 10–76 S. 10–87–9, and 11–81 10. The branchiostegals in various specimens examined are 9 to 10; divided dorsal rays, 10 to 11; anal rays, 10 to 11.

Genus ARGYROSOMUS Agassiz

This genus is very close to Coregonus, from which it differs in the larger mouth and more produced jaws, the premaxillaries being placed nearly horizontally, and the lower jaw decidedly projecting beyond them. Gill rakers very long and slender, about 30 on lower limb; vertebrae 55. These characters are associated with the greater voracity and, in general, greater activity of the species of Argyrosomus. The species are numerous in the northern parts of Europe, Asia and North America, and all are valued as food.

125 Argyrosomus osmeriformis (H. M. Smith)

Smelt of New York lakes

Coregonus hoyi BEAN, Proc. U. S. Nat. Mus. V, 658, 1883; GOODE, Fish & Fish. Ind. U. S. pl. 197 B, 1884; not *Coregonus hoyi* Gill.

Coregonus osmeriformis SMITH, Bull. U. S. F. C. XIV, 2, pl. 1, fig. 2, 1895. Lakes Seneca and Skaneateles, New York.

Argyrosomus osmeriformis JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 468, 1896.

Body elongate, moderately compressed, slender; head less compressed than body, its greatest width equaling one half the distance from tip of lower jaw to nape, the lower jaw projecting considerably even when the mouth is closed; mouth large, the maxillary reaching to the vertical through the anterior margin of the pupil; preorbital bone long and slender, more than one third as long as the head; supraorbital as long as the eye, four times as long as broad.

The greatest hight of the body is considerably less than the length of the head, and is contained five times in the total length without caudal. The greatest width of the body is less than one half its greatest hight. The least hight of caudal peduncle equals the length of the orbit and about one third of the greatest hight of the body. Scales small, nine in an oblique series from the dorsal origin to the lateral line, 82 tube-bearing scales, and eight in an oblique series from the ventral origin to the lateral line.

The length of the head is one fourth of the total length to the end of the lateral line. The distance of the nape from the tip of the snout is nearly one third of the distance from the tip of the snout to the origin of the first dorsal. The length of the maxilla is one third of the length of the head. The mandible is one half as long as the head. Lingual teeth present. The eye is as long as the snout and one fourth as long as the head. Gill rakers long and slender, the longest five sixths as long as the eye; there are 55 on the first arch, 35 of which are below the angle. The insertion of the dorsal is nearer the tip of the snout than the end of the middle caudal rays. The longest ray of the dorsal equals the greatest length of the ventral and is contained seven times in the total length to the end of the middle caudal rays (six and two thirds times in length to end of lateral line). The length of the pectoral is one sixth of the standard body length.

The insertion of the ventral is midway between the tip of the snout and the end of the middle caudal rays. When the ventral is extended, the distance of its tip from the vent is only one

fourth of the length of the fin. In this respect this species differs widely from C. a r t e d i.

Colors. Back grayish silvery; sides silvery; dorsal and caudal with darker tips.

Radial formula. D. iii, 9; A. ii, 13; V. i, 12; P. i, 16. Scales 9–82–8.

MEASUREMENTS

Current number of specimen 32,162

	Millimeters	Hundredths of length
Extreme length	253	.....
Length to end of scales	217	100
Body:		
Greatest hight	41	19
Greatest width	18	8
Hight at ventrals	40	18½
Least hight of tail	15	7
Head:		
Greatest length	52	24½
Distance from snout to nape	36	16½
Greatest width	20	9
Width of interorbital area	12	5½
Length of snout	14	6½
Length of operculum	13	6
Length of maxillary	18	8
Length of mandible	26	12
Diameter of eye	13	6
Dorsal (*first*):		
Distance from snout	112	51½
Length of base	20	9
Length of longest ray	33	15
Length of last ray	11	5
Anal:		
Distance from snout	162	75
Length of base	24	11
Length of longest ray	20	9
Length of last ray	8	4
Caudal:		
Length of middle rays from end of scales	12	5½
Length of external rays	44	20
Pectoral:		
Distance from snout	52	24½
Length	36	16½
Ventral:		
Distance from snout	118	55
Length	32	15
Origin from anal origin	48	22
End of extended ventral to anal origin	15	7

MEASUREMENTS

	Millimeters	Hundredths of length
Dorsal	iii, 9	.....
Anal	ii, 13	.....
Pectoral	i, 16	.....
Ventral	i, 12	.....
Number of scales in lateral line	82	.....
Number of transverse rows above lateral line	9	.....
Number of transverse rows below lateral line	8	.....

The attention of the writer was called to this graceful little whitefish by the Rev. W. M. Beauchamp and J. C. Willetts. Mr Willetts forwarded numerous specimens from Skaneateles. Individuals were obtained also from Prof. H. L. Smith, which he received from Seneca lake. One of these specimens, 10 inches long, is described above.

The fish was then somewhat doubtfully supposed by me to be identical with Hoy's whitefish, but it is now known to be distinct.

126 **Argyrosomus artedi** (LeSueur)

Lake Herring; Cisco

Coregonus artedi Le Sueur, Jour. Ac. Nat. Sci. Phila. I, 231, May, 1818. Lake Erie & Lewistown, Upper Canada; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 301, 1883; Bean, Fishes Penna. 69, pl. 26, fig. 48, 1893.

Salmo (Coregonus) harengus Richardson, Fauna Bor.-Amer. III, 210, pl. 90, fig. 2, 1836.

Coregonus clupeiformis De Kay, N. Y. Fauna, Fishes, 248, pl. 60, fig. 198, 1842; Günther, Cat. Fish. Brit. Mus. VI, 198, 1866.

Coregonus harengus Günther, Cat. Fish. Brit. Mus. VI, 199, 1866.

Argyrosomus artedi Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 468, 1896.

The body of the lake herring is moderately elongated, compressed, and the head pointed. The greatest hight of the body at the origin of the dorsal is one fourth of the total length without caudal. The caudal peduncle is short and stout; its least depth is somewhat more than one third of its greatest depth. The eye is contained four to four and one half times in length of head; the snout three and one half times. The maxillary reaches nearly to below the middle of the eye. The lower jaw projects strongly. The dorsal begins midway between tip of snout and base of tail. Its longest ray equals length of

head without snout. The ventral begins under the middle of the dorsal, its longest ray two thirds of length of head. The pectoral is slightly longer than the ventral. The anal base equals the length of its longest ray, which is nearly one half the length of head. The adipose dorsal is slender, its width one half its hight, and about one half the length of eye; 25 to 30 gill rakers below the angle of the first arch. D. 11; A. 10 (counting only divided rays in dorsal and anal); V. 10. Scales 9–80 8. The upper parts are greenish or bluish black; the sides silvery and with narrow pale streaks along the rows of scales, specially above the lateral line.

This species is known as the lake herring or cisco. The name cisco is applied more particularly in the small lakes of Wisconsin, Indiana and New York. The lake herring is most abundant in the Great lakes, extending northward into British America; eastward it has been obtained from Labrador. It becomes variable in certain parts of its habitat, notably in Labrador and in the lakes in which it is known as cisco. In 1885 more individuals of this species were taken in Lake Erie than in all the other Great lakes put together, more than 19,000,000 pounds having been caught there out of a total of less than 26,000,000.

The average length of this species is about 1 foot, and the weight 9 to 12 ounces, but examples measuring 19 inches in length and weighing 2 pounds have been recorded.

The lake herring frequents shoal waters moderately, and occurs in enormous schools, as one may judge from the quantity captured in Lake Erie. Its food consists of insects and crustaceans. During the spawning season of the whitefish, however, it feeds exclusively on the eggs of this species and proves very destructive. The lake herring will take the hook, and has been caught with live minnows. Spawning takes place about the end of November in shoal waters.

As a food fish this species is inferior to the whitefish, but it is in great demand over an extensive area of the country, and is shipped in the fresh condition many hundreds of miles east and west. I have elsewhere referred to the enormous number

taken in 1885 in Lake Erie. These are caught chiefly in pound and gill nets. The catch in 1885 amounted to more than one third of the entire quantity of fishes taken in this lake. There is no apparent diminution in the number of these fishes, and their artificial propagation has not been practised.

A male and a female were forwarded by Mr Annin from Three-mile bay, Lake Ontario, Nov. 22 and 25, 1895.

MEASUREMENTS

	MALE Inches	FEMALE Inches
Length, including caudal	13½	13
Length of middle caudal rays	¾	.....
Least depth of caudal peduncle	1	.....
Depth of body at dorsal	3	2½
Length of head	2¼	2¼
Length of maxilla	¾	⅞
Diameter of eye	½	½
Length of longest gill raker	⅝	.....

The male has 17+31 gill rakers; the female, 47. Scales of the male, 8–74–8; of the female, 76.

In the female the maxilla reaches to the front of the pupil; the lower jaw projects a little; the dorsal and anal each have 10 divided rays; the dorsal has a black tip; the pectoral is dusky above; the ventral and anal are pale; the caudal is dusky towards its margin.

The cisco, according to Mr Annin, lives in deep waters and spawns in brooks in December.

Dr Meek saw a few specimens of the species from Cayuga lake. The U.S. Fish Commission obtained four specimens at Cape Vincent N. Y. Nov. 11 and 17, 1891. The U. S. National Museum has a number of examples from Lake Champlain, some of them from Vergennes Vt., and others from Ticonderoga N. Y. DeKay says the shad salmon occurs in the smaller lakes in the interior of the state, which still communicate with our inland seas.

127 Argyrosomus hoyi Gill

Mooneye Cisco; Shiner

Argyrosomus hoyi Gill, Mss. Jordan, Amer. Naturalist, 135, March, 1875, Lake Michigan, near Racine, Wis.; Evermann & Smith, Rept. U. S. F. C. XX, 310, pl. 22, 1896; Bean, Bull. Amer. Mus. Nat. Hist. IX, 342, 1897, Canandaigua Lake; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 469, 1896.

Coregonus hoyi JORDAN, Man. Vert. ed. 2, 275, 1878; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 299, 1883; SMITH, Bull. U. S. F. C. XIV, 6, pl. 1, fig. 1, 189.

Head, four; depth, four and four sevenths; eye, five (nearly); snout, three and one half; maxillary, nearly three in head, reaching to vertical through front of pupil. D. 10; A. 11. Scales, 8–70–9. Gill rakers, 14+28, left side, 40 on right side, longest about $\frac{1}{4}$ inch, about two in eye. Branchiostegals, 8. Body rather elongate, compressed, the back little elevated; mouth rather large, terminal, the lower jaw slightly longer than upper when the mouth is closed; tip of muzzle conical as in A. artedi; mandible nearly reaching vertical through posterior edge of eye, nearly two in head; head rather long and slender, with pointed snout; interorbital width equal to eye; supraorbital and preorbital long and narrow; distance from tip of snout to occiput two in distance from occiput to origin of dorsal fin; dorsal rays much longer anteriorly than posteriorly, the longest ray nearly equal to distance from front of pupil to end of head, the last ray only one third as long; longest anal ray two and one half in head, last anal ray two fifths as long as the longest; pseudobranchiae well developed; tongue with evident teeth. Color in spirits silvery, with purplish iridescence on back; scales without punctulations; belly whitish; dorsal and caudal fins dark on terminal half, pale at base; other fins all pale. Length, without caudal, 8 inches; total length, $9\frac{1}{2}$ inches; depth $1\frac{3}{4}$ inches; head, $2\frac{1}{8}$ inches; eye, $\frac{7}{16}$ inch; maxilla, $\frac{11}{16}$ inch; interorbital width equal to diameter of eye.

Mr Annin wrote me that the people at Canandaigua lake told him that there were large quantities of small lake shiners, as they are called, in the lake. A fisherman said that they are seen in immense schools at the top of the water occasionally, and, by firing a gun loaded with shot into them, men can stun them so as to pick up quite a number. They are eagerly sought after for trolling bait for the salmon trout found in that lake.

This species is recorded with certainty from Lake Michigan only. It is taken in gill nets in deep water and, notwithstanding its small size, has become commercially important. It is

here for the first time announced as a member of the New York fauna, and the description leaves no doubt of the correctness of the identification. The fish examined, a female with ripe eggs, was taken in Canandaigua lake, Dec. 19, 1896, by Mr Annin's men. It was the only one caught, and was captured by becoming gilled in the funnel of the net. Mr Annin is satisfied that this is the lake shiner of the fishermen, which they sometimes see in immense schools at the surface, and kill for trolling bait by shooting them.

128 **Argyrosomus prognathus** (H. M. Smith)

Long Jaw; Bloater

Coregonus prognathus Hugh M. Smith, Bull. U. S. F. C. XIV, 4, pl. 1, fig. 3. 1895, Lake Ontario, at Wilson N. Y.

Argyrosomus hoyi Milner, Rept. U. S. F. C. II, 86. 1874, Outer Island, Lake Superior, not of Gill.

Argyrosomus prognathus Evermann & Smith, Rept. U. S. F. C. XX, 314, pl. 26, 1896; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 471, 1896.

Body oblong, much compressed, back elevated, tapering rather abruptly toward the narrow caudal peduncle, the adult fish having a slight nuchal hump as in C. c l u p e i f o r m i s; greatest depth three and one half to four in body length; head rather short and deep, pointed, four to four and one third in length; greatest width half the length, cranial ridges prominent; snout straight, its tip on level with lower edge of pupil; top of head two in distance from occiput to front of dorsal; mouth large and strong, maxillary reaching to opposite middle of pupil, two and one half in head, length three times its width, mandible long, projecting beyond upper jaw when mouth is closed, reaching to or beyond posterior edge of eye, one and three fourths to one and seven eighths in head; eye small, five in head, one and one half in snout, one and one third in interorbital space, one and one half in suborbital space; gill rakers slender, about length of eye, 13 above and 25 below angle. Adipose fin the length of eye, its width half its length. Narrowest part of caudal peduncle contained nearly four times in greatest body depth. Dorsal rather high, with nine or ten developed rays, the longest one half longer than base of fin and contained one and three

fourths times in greatest body depth, three and one fourth times in distance between dorsal and snout, and one and one half times in head; free margin slightly concave; origin midway between end of snout and base of caudal; dorsal base opposite nine scales. Anal with 10 to 12 developed rays, the longest ray equal to base of fin and two thirds of hight of dorsal. Ventrals as long as dorsal is high, their origin midway between anterior edge of orbit and base of caudal. Ventral appendage short, covering about three scales. Pectorals as long as ventrals. Scales rather large, about 75 in lateral line, seven or eight above the lateral line, seven or eight below the lateral line. Lateral line straight except at origin, where it presents a rather marked curve. Sides of body uniformly bright silvery, with pronounced bluish reflection in life; the back dusky, the under parts pure white without silvery color. Above lateral line, light longitudinal stripes involving central part of scales extend whole length of body. Fins flesh color or pinkish in life, the dorsal and caudal usually showing dusky edges; postorbital area with a bright golden reflection; iris golden, pupil black. Branchiostegals, eight. Average length, 15 inches.

Habitat: Lake Ontario, Lake Michigan, Lake Superior, and doubtless the entire Great lake basin, in deep water. This fish is called long-jaw in Lakes Michigan and Ontario. Specimens were obtained from John S. Wilson of Wilson N. Y. and from George M. Schwartz of Rochester N. Y. Dr R. R. Gurley also secured examples at Nine Mile Point N. Y. in June 1893.

This species is quite different from any other whitefish inhabiting the Great lake basin. It may be at once distinguished from all the whitefishes known to occur in the United States by the general form of body combined with the very long lower jaw, which is contained less than twice in the length of the head and extends backward to or beyond the posterior edge of orbit.

129 **Argyrosomus tullibee** (Richardson)

Tullibee; Mongrel Whitefish

Salmo (Coregonus) tullibee Richardson, Fauna Bor.-Amer. III. 201, 1836, Cumberland House, Pine Island Lake.

Coregonus tullibee GÜNTHER, Cat. Fish. Brit. Mus. VI, 199, 1866; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 301, 1883; JORDAN, Cat. Fish. N. A. 43, 1885; BEAN, Fishes Penna. 70, pl. 27, fig. 49, 1893.

Argyrosomus tullibee JORDAN, Man. Vert. ed. 2, 361, 1878; EVERMANN & SMITH, Rept. U. S. F. C. XX, 320, pl. 28, 1896; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 473, 1896; BEAN, Bull. Amer. Mus. Nat. Hist. IX, 343, 1897.

The body of the tullibee is very short, deep and compressed; its greatest hight about one third of the length without caudal. The head is pointed, as in the blackfin, the mouth large, with the lower jaw scarcely longer than the upper. The maxilla extends to below the middle of the eye. The eye equals the snout in length and is two ninths of length of the head. Scales much larger on front part of body than on the caudal peduncle. The gill rakers are long, slender and numerous, about 30 below the angle on the first arch. D. 11; A. 11. Scales in lateral line 74, eight rows above and seven below lateral line; pyloric caeca, 120. The upper parts are bluish; sides white and minutely dotted. The spermary, according to Richardson, is wood brown.

This species is usually called the tullibee, but in Lakes Erie and Michigan it is sometimes styled the mongrel whitefish on the supposition that it is a cross between the common whitefish and the lake herring.

The tullibee has been taken recently in Lake Michigan; and Dr E. Sterling had a specimen from Lake Erie. It is found occasionally in others of the Great lakes and extends northward into British America; but is comparatively little known to the fishermen and is very rare in collections. This fish grows to a length of 18 inches.

The late F. C. Gilchrist was the first to describe the habits of the tullibee, and this he did in *Forest and Stream* in the following language.

In September they will again be found gradually nearing the shoal water, feeding heavily, and plump with fat and the now swelling ovaries. Later on they appear to eat little or nothing and devote all their time to playing until about the 25th of October, when they have settled down to the business of propagation, which they have finished by November 10. They prefer shallow water close to shore with clean sand to spawn on, and

during the day they may be seen in pairs and small schools, poking along the shores, but at night they come in thousands and keep up a constant loud splashing and fluttering, very strange and weird on a calm night. Two years ago I carefuly counted the ova from a ripe fish 2½ pounds in weight, and found there were 23,700, closely resembling whitefish eggs in appearance, but somewhat smaller. After spawning the fish are very thin, lank, dull in color, and quite unfit for human food.

James Annin jr furnished me the following notes on the spawning of the tullibee in Onondaga lake, N. Y.

They generally commence running up onto the shoals about November 15, and the season extends into December. They come up to the banks or gravelly shoals and spawn in from 3 to 6 and 7 feet of water. They have never been caught with the hook in this lake; and an old fisherman told me that he had tried almost every kind of bait, and had used the very finest gut and the smallest hooks baited with Gammarus (fresh-water shrimp) and other kinds of natural food—that is, he supposed the food was natural to them. At the same time, he claims he could see them in large schools lying in the water 8 or 10 feet from the surface.

A female tullibee was sent from Onondaga lake by Mr Annin Nov. 18, 1895, and another of the same sex Nov. 25, 1896.

The following notes relate to the female obtained Nov. 18, 1895.

	Inches
Length to end of caudal	18½
Length of upper caudal lobe	2⅝
Length of middle caudal rays	1
Least depth of caudal peduncle	1⅜
Depth of body at dorsal origin	4⅝
Length of head	3¼
Length of maxilla	⅞
Diameter of eye	⅝
Length of longest gill raker	⅛

The mandible projects slightly. B. 8; D. 11; A. 11; V. 11. Scales 8–75–8; gill rakers, 17+27.

The female received Nov. 25, 1896, is 15 inches long.

New York is well supplied with Coregonidae, having seven of the 16 North American species. C. quadrilateralis is the frostfish of the Adirondacks and the Great lakes. C. clupeiformis, the common whitefish, inhabits the Great lakes and Lake Champlain; it is very abundant also in the

Adirondacks. Argyrosomus osmeriformis is a shapely little herring of Seneca and Skaneateles lakes. A. artedi is the common lake herring or cisco of the Great lakes and Lake Champlain. A. hoyi, the lake shiner, or Hoy's whitefish, is above recorded from Canandaigua lake. A. prognathus, the long-jaw, the only summer spawning whitefish so far as known, lives in Lake Ontario; and, finally, A. tullibee, is the fine whitefish of Onondaga lake.

Genus ONCORHYNCHUS Suckley

Body elongate, subfusiform, or compressed; mouth wide, the maxillary long, lanceolate, usually extending beyond the eye; jaws with moderate teeth, which become in the adult male enormously enlarged in front; vomer long and narrow, flat, with a series of teeth both on the head and the shaft, the latter series comparatively short and weak; palatines with a series of teeth; tongue with a marginal series on each side; teeth on vomer and tongue often lost with age; no teeth on the hyoid bone; branchiostegals more or less increased in number; scales moderate or small; dorsal fin moderate; anal fin comparatively elongate, of 14 to 20 rays; pyloric appendages in increased number; gill rakers rather numerous; ova large; sexual peculiarities very strongly developed; the snout in the adult males in summer and fall greatly distorted, the premaxillaries prolonged, hooking over the lower jaw, which in turn is greatly elongate and somewhat hooked at tip, the teeth on these bones also greatly enlarged. The body becomes deep and compressed, a fleshy hump is developed before the dorsal fin, and the scales of the back become embedded in the flesh; the flesh, which is red and rich in spring, becomes dry and poor. Salmon, mostly of large size, ascending the rivers tributary to the north Pacific in North America and Asia, spawning in the fall.

130 Oncorhynchus tshawytscha (Walbaum)

* *King Salmon; Quinnat Salmon; Chinook Salmon* (Introduced)

Salmo tshawytscha WALBAUM, Artedi. Gen. Pisc. III, 71, 1792.

Salmo quinnat RICHARDSON, Fauna Bor.-Amer. III, 219, 1836; GIRARD, Pac. R. R. Exp. Fish. 306, pl. 67, 1858.

Oncorhynchus quinnat GÜNTHER, Cat. Fish. Brit. Mus. VI, 158, 1866.

Oncorhynchus orientalis GÜNTHER, op. cit. 159, 1866.

Oncorhynchus choucha JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 396, 1883; STONE in Fish & Fish. Ind. U. S. I, 479, pl. 186, lower fig. 1884; BEAN, Bull. U. S. F. C. IX, 190, pl. XLVI, fig. 1, 1891; Fishes Penna. 72, 1893.

Oncorhynchus tschawytscha JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 479, 1896, pl. LXXVII, fig. 206, 1900.

Body stout, moderately elongate, its greatest depth contained three and two thirds to four times in total length without caudal; caudal peduncle short and stout, its least depth one third of greatest depth of body; head conical, pointed, its length one fourth of total length without caudal; eye small; less than one half of length of snout, and about one seventh of length of head; maxilla slender, its width scarcely one fourth its length, which is one half the length of head; nostrils nearly midway between eye and tip of snout; teeth small, longer on sides of lower jaw than in front, vomerines few and weak, disappearing in the males; gill rakers usually about 23, of which 14 are below the angle of the first arch; dorsal origin midway between tip of snout and base of upper external caudal rays, the base of the fin as long as the longest ray, one half as long as the head, the last ray two fifths as long as the longest; adipose fin over the end of the anal, its width scarcely one half its length, which is two sevenths of the length of the head. The anal base is three fifths as long as the head; the longest anal ray is two fifths as long as the head and more than twice as long as the last ray. The ventral is under the last rays of the dorsal, midway between front of eye and base of caudal, its length one half the length of head, its appendage one half as long as the fin. Pectoral as long as postorbital part of head. B. usually 17 or 18; D. 11; A. iii, 15 or 16. Scales usually 27–146–29, sometimes as many as 155 in a longitudinal series. Vertebrae 66. Pyloric caeca 140 to 185.

The quinnat salmon is the largest and finest of the Pacific salmon. It ranges from Monterey Cal. to Alaska and eastern Asia, ascending rivers in some cases 1500 miles or farther from the sea. It has been introduced into lakes of New York, but there is no evidence that it has become established in any waters of the state. Possibly better results might be secured if larger fish were selected for the experimental stocking.

This is the largest fish of the salmon family, individuals weighing 100 pounds and measuring upward of 5 feet in length being on record from the Yukon and other Alaskan rivers. The average weight of adults is above 20 pounds. The flesh of this salmon is paler in color than that of the red salmon, but it is superior in flavor to all others.

The quinnat is the first to arrive near the shores in the spring, and the time of the run depends on the latitude, becoming later and later till, in Norton sound, the present known northern limit of its migration, it appears early in June. Unless the spawning period be close at hand, it does not ascend rivers rapidly, but generally plays around for a few days, or even a couple of weeks, near the river limit of tide water. It has been estimated that it proceeds up the Columbia river at the rate of 100 miles a month till the exigencies of reproduction compel a faster rate of travel.

In the sea this salmon feeds on herring, caplin, and crustaceans. A male of about 35 pounds, taken at Karluk August 4, had in its stomach 45 caplin. In fresh water the fish take no food.

Spawning takes place near the head waters of streams in clear shallow rapids. The fish excavate oblong cavities in the gravel beds where there is a current, and in these nests the eggs and milt are deposited. The eggs are protected from some of their enemies and fatalities by their environment, but are still a prey to freshets and to the pestiferous little fresh-water sculpins, or blobs, that abound in all trout and salmon waters, so far as observed. The young are hatched in from 60 to 100 days. They are destroyed in large numbers by aquatic birds, blobs, and large fishes. The adults are killed by seals, sea lions, and sharks. After spawning, nearly all the parent fish die, specially those that ascend rivers a long distance.

The quinnat is a very valuable fish for canning, salting and smoking. If it could be acclimated in the Great lakes, it would form the basis of new and important industries. The practicability of rearing this species in fresh waters without access to the sea has been satisfactorily demonstrated in France by Dr Jousset de Bellesme, director of the aquarium of the Trocadéro.

The results of the experiment of introducing this salmon into New York waters are as yet unknown, but it is to be hoped that it will be successful. Since the change of method by which larger fish are employed for transplanting, the outlook appears to be more favorable.

Genus SALMO (Artedi) Linnaeus

Body elongate, somewhat compressed; mouth large, jaws, palatines, and tongue toothed, as in related genera, vomer flat, its shaft not depressed, a few teeth on the chevron of the vomer, behind which is a somewhat irregular single or double series of teeth, which in the migratory forms are usually deciduous with age; scales large or small, 110 to 200 in a longitudinal series; dorsal and anal fins short, usually of 10 to 12 rays each; caudal fin truncate, emarginate or forked, its peduncle comparatively stout; sexual peculiarities variously developed, the males in typical species with the jaws prolonged and the front teeth enlarged, the lower jaw being hooked upward at the end and the upper jaw emarginate or perforate. In the larger and migratory species these peculiarities are most marked. Species of moderate or large size, black spotted, abounding in the rivers and lakes of North America, Asia and Europe; no fresh-water species occurring in America east of the Mississippi valley; two Atlantic species, marine and anadromous. The nonmigratory species (subgenus T r u t t a) are in both continents very closely related and difficult to distinguish, if indeed all be not necessarily regarded as forms of a single one. The excessive variations in color and form have given rise to a host of nominal species.

131 Salmo salar Linnaeus

Atlantic Salmon

Salmo salar LINNAEUS, Syst. Nat. ed. X, I, 308, 1758; Seas of Europe; MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 435, 1815; DE KAY, N. Y. Fauna, Fishes, 241, pl. 38, fig. 122, 1842; GÜNTHER, Cat. Fish. Brit. Mus. VI, 11, 1866; STORER, Hist. Fish. Mass. 142, pl. XXV, fig. 2, 1867; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 312, 1883; GOODE, Fish & Fish. Ind. U. S. I. 468, pl. 186, upper fig. 1884; BEAN, Fishes Penna. 74, color pl. 4, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 486, 1896; BEAN, Bull. Amer. Mus. Nat. Hist. IX, 344, 1897.

The Atlantic salmon has a moderately thick and elongate body. The greatest hight, at the origin of the dorsal fin, is two ninths of the total length without caudal. The caudal peduncle is rather slender; its least depth about one third of the greatest depth of body. The head is comparatively small; its length in the female about one fifth of total without caudal. The eye is placed at a distance from the top of the head equal to its own diameter. It is one half as long as the snout, and about one seventh of length of head. The maxillary reaches a little past the eye in adults. Its length equals the depth of caudal peduncle. The dorsal origin is midway between tip of snout and adipose fin. The adipose fin is long and narrow, its width one half its length, and equal to length of eye. The base is slightly longer than its longest ray, and nearly one eighth of total without caudal. The last dorsal ray is about one third of length of dorsal base. The ventral origin is nearly under the end of the dorsal base. The length of the fin equals one half the length of head. The appendage is two fifths of the length of the fin. The pectoral is as long as the dorsal base. The distance of the ventral origin from the anal origin is a little more than length of head. The longest anal ray equals length of ventral. The last ray is two fifths of length of longest. B. 11; D. 11 divided rays and 3 rudiments; A. 9 divided rays and 3 rudiments. Scales 23, 120, 21. Vertebrae 60. Pyloric cæca 60 to 70. In the adult the upper parts are brownish or grayish; the sides silvery. Numerous X-shaped or XX-shaped black spots on the upper half of the body, side of the head, and on the fins. Males in the breeding season have red blotches along the sides. In the young there are from 10 to 12 dark crossbars mingled with red blotches and black spots.

The salmon in America has but a single common name. When the young have reached a length of 2 inches and taken on the vermilion spots and dark cross bands, they are called parr, and retain this name while they remain in fresh water. Before descending to the sea in the second or third spring, the parr assumes a bright silvery coat and is then known as a smolt.

After a sojourn in salt water lasting from four months to about two years, it may return to its native river either as a sexually immature salmon or as a grilse, the female not yet ready for reproducing its species though the male is sexually mature. The landlocked variety of the Atlantic salmon has been variously denominated fresh-water salmon, Schoodic trout, Sebago trout, dwarf salmon and winninish, the last in use in the Saginaw region. In some Nova Scotian rivers a misnomer, grayling, is applied to the landlocked salmon.

This species inhabits the north Atlantic, ascending rivers of Europe and America for the purpose of reproduction. In Europe it extends southward to France, and in the United States the most southern river in which specimens have been obtained is the Potomac. It occurs in small numbers in the Delaware and in large numbers in the Hudson, but in the last three river basins mentioned its presence is the result of artificial introduction. It is not found in abundance south of the Merrimac, and in rivers of New England and Canada in which it is native it is maintained almost exclusively by artificial culture. The usual weight of the Atlantic salmon ranges from 15 to 40 pounds, but individuals weighing 60 pounds have been recorded. The growth of the salmon is accomplished chiefly in the ocean. As a rule the adults enter the rivers on a rising temperature when ready to deposit their eggs, the spawning occurring on the falling temperature in water not warmer than 50°. The time of entering the Delaware and Hudson is April, the Connecticut a little later, the Merrimac still later; to the Penobscot the salmon come most abundantly in June and July; and to the Miramichi from the middle of June to October. The salmon is not much affected by changes in temperature of the water, enduring a range of fully 45°. The eggs are deposited in shoal water on sandy or gravelly bottom, the parent fish making deep depressions by means of their noses or by flopping motions of the tail. The period of egg-depositing lasts from 5 to 12 days. The spawning season begins about the middle of October and may run into December. In some European

rivers the season continues till February. The eggs are about one fourth of an inch in diameter, and the female is estimated to have about 1000 for each pound of her weight. In the Penobscot, according to the observations of Mr Atkins, an eight pound female yields from 5000 to 6000 eggs; and a female of 40 pounds about 15,000 eggs. The hatching period ranges from 140 to 200 days or more, depending on the temperature. A newly hatched salmon is about three fourths of an inch long, and the yolk sack is absorbed in from a month to six weeks. It then begins to feed on small organisms in the water. At the age of two months it measures 1½ inches and begins to show crossbars and red spots, gradually coming into the parr stage. In the sea the salmon feeds on herring, caplin, sand lance, smelt and other small fishes, besides crustaceans; but during its stay in fresh water it takes no food.

Among the worst enemies of salmon eggs are trout, eels, suckers and frogs. Numerous species of birds destroy the fry, among them sheldrakes, kingfishers, gulls and terns.

The value of the salmon as a food and game fish is so well known as to require no description here. Those that find their way into market are usually caught in pound nets, gill nets or seines, and the bulk of them are taken at or near the mouths of the streams which they are about to enter for the purpose of spawning. Many are captured in the upper reaches of streams by the spear.

Eggs of the Atlantic salmon, just on the point of hatching, from the Restigouche river, Canada, were received at the New York aquarium from Percy Baker about May 1, 1897. Several hundred healthy embryos were obtained from them. These were reared almost without loss till June 18, when the temperature of the water had reached 76° and nearly all perished. November 27, one of the few survivors was 3⅜ inches long. Liver was the principal food of the fry.

Mitchill, in the first volume of the transactions of the Literary and Philosophical Society of New York, says that the salmon "has been taken, since the discovery, a few times in the Hudson.

But here he is a straggling fish, and not in his regular home. There is no steady migration of salmon to this river. Though pains have been taken to cherish the breed, salmon has never frequented the Hudson in any other manner than as a stray."

In 1842 DeKay published the following note:

The sea salmon rarely now appears on our coast except as a straggling visitor. Such an occurrence took place in August 1840, when a salmon weighing 8 pounds entered the Hudson river, and ascended it more than 150 miles, when it was taken near Troy. . . It now is only seen on our northern borders, ascending the St Lawrence from the sea, and appearing in Lake Ontario in April, and leaving it again in October or November. They were formerly very abundant in the lakes in the interior of the state which communicated with Lake Ontario; but the artificial impediments thrown in their way have greatly decreased their numbers, and in many cases caused their total destruction. I have seen some from Oneida lake weighing 10 and 15 pounds. . . They are occasionally found in Lake Ontario during the whole year; but, as the same instinct which compels them to ascend rivers also leads them again to the sea, and as there is no barrier opposed to their return, we may presume that these are sickly or possibly barren individuals.

Experiments for restocking the Hudson are now in progress and it is probable that the river may again become a salmon stream.

132 Salmo salar sebago (Girard)

Landlocked Salmon (Introduced)

Salmo sebago Girard, Proc. Ac. Nat. Sci. Phila. 380, 1853, Sebago Lake Maine; Günther, Cat. Fish. Brit. Mus. VI, 153, 1866.

Salmo salar var. *sebago* Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 312 1883.

Salmo gloverii Girard, Proc. Ac. Nat. Sci. Phila. 85, 1854; Günther, Cat. Fish. Brit. Mus. VI, 153, 1866.

Salmo salar sebago Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 487 1896; Bean, Bull. Amer. Mus. Nat. Hist. IX, 344, 1897.

There are at least two well marked races of salar salmon which do not enter the sea but live permanently in fresh water. Both of these differ from the migratory salmon in several particulars: they are smaller, their eggs are larger, they retain the parr marks much longer, they are more subject to disease attending the egg-producing season, and the young grow more

rapidly. The ouananiche of the Saguenay river country is the farthest removed from the typical sea salmon by its very much smaller size, larger fins and different pattern of coloration.

The larger of the two landlocked salmon of the United States is found in the four river basins of the state of Maine, the Presumpscot, Sebec, Union and St Croix. Here the weights vary considerably, spawning fish ranging all the way from 3 pounds to 10 or 12 pounds, while occasional individuals reach 25 pounds. The Sebago form is the one that has been introduced into the Adirondack lakes and other New York waters. Spawning begins late in October, but is at its hight in November. Eggs are shipped in January, February and March, and the fry are ready for planting in June.

At Green lake, Me., the landlocked salmon often endure a summer temperature above 80° F., but they refuse to take food when the water reaches 75°.

This salmon has been introduced into New York waters from Maine, and appears to have become established in several localities. A very fine example was obtained from the South Side Sportsmen's Club of Long Island, but it was injured in transportation and never recovered. In April 1896 several individuals from Maine were presented by Eugene G. Blackford. One of these lived in a tank of salt water in the New York aquarium for 19 months, and was then frightened by visitors when the water was drawn low for cleaning, and injured itself so badly that it died after a few hours of struggling. The following measurements were obtained from the fresh fish.

	Inches
Length	24
Middle caudal rays from end of scales	1⅝
Depth	4
Least depth of caudal peduncle	1⅝
Head	4¾
Snout	1¼
Eye	⅝
Orbit	¾
Snout to dorsal	9½
Dorsal base	2¾
Longest dorsal ray	2⅜
Last dorsal ray	1¼

	Inches
Snout to ventral	11¼
Length of ventral	2¼
Snout to anal	16⅜
Anal base	1⅞
Longest anal ray	1⅞
Last anal ray	1⅛
Snout to adipose dorsal	17⅝
Width of adipose dorsal	½
Length of adipose dorsal	¾
Length of pectoral	3¼
Upper jaw	2¼
Maxilla	2

The head has about 28 dark spots, the largest on the gill cover, oblong, ⅜ inch long. Body with many large and small black spots, a few with a pale ring around them, and some as large as the largest on the gill cover; one on the caudal peduncle of one side distinctly X shaped. General color dark bluish gray; belly and lower parts iridescent silvery; fins all dusky; the dorsal with many black spots; eye pale lemon, the upper part dusky.

Gill rakers, 9+11, the longest ⅛ inch. B. 11; D. 10. Scales, 21–123–20.

133 Salmo henshawi Gill & Jordan

Lake Tahoe Trout; Red-throat Trout (Introduced)

Salmo henshawi Gill & Jordan, Man. Vert. ed. 2, 358, 1878, Lake Tahoe; Rept. Chief Eng. Part 3, 1878, App. NN, 1619, pl. IV; Jordan, Proc. U. S. Nat. Mus. I, 75, 1878.

Salmo purpuratus var. *henshawi* Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 316, 1883.

Salmo mykiss Cheney, Third Ann. Rept. N. Y. Comm. Fish. 239, color pl. facing p. 238, 1898.

Salmo mykiss henshawi Jordan, Bull. U. S. F. C. IX, 14, pl. II, fig. 5, 1891; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 493, 1896.

Salmo clarkii henshawi Jordan & Evermann, op. cit. 2819, pl. LXXIX, fig. 208, 1900.

Body elongate, not much compressed, its greatest depth one fourth of the total length without caudal; caudal peduncle rather long; its least depth equaling two fifths of the length of the head; head long, conical, slender, its length contained about four times in the total to caudal base; a slight keel on the top of the head; snout obtusely pointed; maxilla not extending far behind the eye, about equal to pectoral, which is three fifths of

length of head; gill rakers short and stout, about 18 on the first arch, of which 13 are below the angle; vomerine teeth in two long, alternating series; hyoid teeth rather weak, in a small patch; dorsal fin small, its last rays two thirds as long as the highest; anal fin rather high; caudal short and distinctly forked. D. 9 to 11; A. 12; B. 10. Scales 27 to 37–160 to 200–27 to 40; pyloric caeca 50 to 60.

Color dark green in life, varying to pale green; the sides silvery with a broad coppery shade which extends also on the cheeks and opercles; a yellowish tinge on the sides of the lower jaw and red or orange dashes between its rami; back everywhere covered with large, roundish black spots; dorsal, adipose fin and caudal fin with similar spots, and a few on the anal; belly with black spots.

The Tahoe trout is a large species inhabiting Tahoe lake, Pyramid lake, Webber lake, Donner lake, Independence lake, Truckee river, Humboldt river, Carson river, and most streams of the east slope of the Sierra Nevada; it occurs also in the head waters of Feather river, west of the Sierra Nevada, probably by introduction from Nevada.

The usual weight is 5 or 6 pounds, but individuals weighing 20 to 29 pounds are recorded.

Eggs of the Lake Tahoe (Cal.) trout were obtained by James Annin jr at Caledonia N. Y., and young fish reared at his establishment were sent to the aquarium in November 1896. They throve till the latter part of June 1897, when they were overcome by the warm water. They could not endure a transfer to the cooler salt water, like most of the other fish of the salmon family.

At Caledonia station, according to Mr Cheney, this fish begins to spawn before the middle of March and continues for two months. The impregnation of eggs is from 90% to 95%, but just before the hatching period a large number of the eggs burst and the embryos are lost. There is loss too between the hatching and feeding times, and the fry do not feed as readily as the brook trout. Altogether, Mr Annin, the superintendent of

hatcheries, estimates the total loss between impregnation of the eggs and feeding of the fry as about 40%. After the fry begin to feed, they are not more difficult to rear than brook trout.

134 Salmo gairdneri Richardson

Steelhead; Gairdner's Trout; Salmon Trout (Introduced)

Salmo gairdnerii RICHARDSON, Fauna Bor.-Amer. III. 221. 1836. Columbia River.

Fario gairdneri GIRARD, Pac. R. R. Surv. Fishes, 313, pl. LXXI, fig. 1, 1858.

Salmo purpuratus GUNTHER, Cat. Fish. Brit. Mus. VI. 116. 1866, not of Pallas.

Salmo gairdnerii GUNTHER, op. cit. 118. 1866.

Salmo gairdneri JORDAN & GILBERT, Bull. 16. U. S. Nat. Mus. 313. 1883; BEAN, Bull. U. S. F. C. IX. 198, pl. XLIX, fig. 9, 1891, not fig. 10, which is young *nelsoni*; JORDAN & EVERMANN, Bull. 47. U. S. Nat. Mus. 498. 1896 (p. LXXXI, fig. 17, 1896—Clear L.). Third Ann. Rep. N. Y. Comm. Fish. 241, color pl., 1898

Form of S. salar. Body elongate, little compressed, its greatest depth two ninths of the total length without caudal; caudal peduncle short, its least depth three sevenths of length of head; head rather short, one fifth of total length without caudal, maxilla reaching far behind the eye, its length one half the length of head; eye small, two thirds of length of snout, two elevenths as long as the head; teeth rather small, vomerines in two long, alternating series about as long as the palatine series; gill rakers short and stout, about 20 on the first arch, of which 12 are below the angle; dorsal origin much nearer to tip of snout than to base of caudal, base of dorsal two thirds of length of head, longest dorsal ray one half the length of head and twice as long as last ray; adipose fin very small and narrow, over the beginning of the anal; caudal fin moderately forked in the young; ventral origin midway between tip of snout and base of caudal, ventral fin one half the depth of body; anal base one half as long as the head, longest anal ray equal to postorbital part of head; pectoral fin one eighth of total length without caudal. B. 11 or 12; D. 11; A. 12. Scales from 137 to 177, usually about 150–28; pyloric caeca 42; vertebrae 38–20= 58. Color olive green above, sides silvery, head, back, dorsal

and caudal fins profusely covered with small black spots, no red between the rami of the lower jaw.

The steelhead trout is found in coastwise streams from southern California to Bristol bay, Alaska. It spawns in the late winter and early spring; ripe eggs were obtained at Sitka, Alaska, June 10. Spent fish of this species are frequently taken with the spring run of the king salmon.

The economic value of the steelhead is very great; the fish reaches a weight of 30 pounds, though the average weight is under 20 pounds, and the non-anadromous forms seldom exceed 5 or 6 pounds.

From information furnished by Mr Annin it appears evident that some of the eggs of trout received at Caledonia N. Y. many years ago from the McLeod river, Cal., as rainbows, really included both rainbows and steelheads. He finds certain females producing deep salmon colored eggs, while in the same pond and receiving the same food as other females which furnish very light colored, almost white, eggs. Some of the females also differ from others in going to the spawning beds nearly two months earlier. It is now known also that the McLeod contains a small-scaled form of the rainbow, known to the Indians as the *no-shee*, and this also may easily have been sent to the east under the name of rainbow. Striking differences in the appearance and habits of so called rainbows introduced into the various states, lend color to this supposition.

Steelheads were obtained for the New York aquarium in November 1896, from the U. S. Fish Commission. They were hatched from eggs shipped from Fort Gaston Cal. to the station at Craig brook, Me. The length of the trout when received ranged from 4 to 4½ inches. After one year they were 10 inches long on the average, and weighed many times as much as they did when received. None of them at any time showed a red lateral band such as is present in the rainbow, and they are farther distinguished by the presence of white tips on the ventral and anal fins; the dorsal also has a small white tip. They have been kept almost from their arrival in salt water, and

could not have been kept in the warm Croton water in June. The salt water never rose above 71½° F and continued at this high temperature only 10 days.

The N. Y. Fisheries, Game and Forest Commission planted some of these trout in a Long Island stream and some in a lake in northern New York. Those that were planted on Long Island, says Mr Cheney, when rather more than a year old rose to the fly of the trout fisherman and made a most gallant fight, but it is too early to tell the outcome of the experiment. The eggs are one fifth of an inch in diameter; they hatch in 42 to 50 days with water at 50°.

135 Salmo fario Linnaeus

Brown Trout (Introduced)

Salmo fario Linnaeus, Syst. Nat. ed. X, I, 30, 1758; Bloch, Ichth. I, 121, taf. 22, & 157, taf. 23, 1785; Richardson, Fauna Bor.-Amer. III, 144, pl. 92, fig. 3, A & B, 1836; Day, Fish. Great. Brit. & Ireland, II, 95, plates CIX, fig.3, CXIII, CXIV, CXVI, fig.1, 1884; Bean, Fishes Penna. 78, color pl. 6, 1893; Jordan & Evermann, Check-List Fish. N. A. 512, 1896.

Salmo fario ausonii Günther, Cat. Fish. Brit. Mus. VI, 64, 1866.

Salar ausonii Cuvier & Valenciennes, Hist. Nat. Poiss. XXI, 319, pl. 618, 1848.

The brown trout of Europe was introduced into the United States from Germany in February 1883 and in subsequent years; it has now become thoroughly acclimated in the fresh waters of many of the states.

The body of this trout is comparatively short and stout, its greatest depth being contained about four times in the length without the caudal. The caudal peduncle is short and deep, its depth equal to two fifths of the length of the head. The length of the head in adults is one fourth of the total length without caudal or slightly less. The diameter of the eye is about one fifth of the length of the head, and less than length of snout. The dorsal fin is placed nearer to the tip of the snout than to the root of the tail; the longest ray of this fin equals the distance from the eye to the end of the opercle. The ventral is under the posterior part of the dorsal; its length is about one half that of the head. The adipose dorsal is placed over the end

of the anal base; it is long and expanded at the end. The caudal is emarginate in young examples, but nearly truncate in specimens 10 inches long. The pectoral is nearly one sixth of the length without the caudal. In the male the jaws are produced, and very old ones have a hook. The maxilla extends to the hind margin of the eye. The triangular head of the vomer has a transverse series of teeth, and the shaft of the bone bears two opposite or alternating series of strong persistent teeth. D. 13–14; A. 10–11; P. 13; V. 9. Scales 25–120–30; pyloric cæca 38–51; vertebrae 57–58.

On the head, body and dorsal fin usually numerous red and black spots, the latter circular or X-shaped and some of them with a pale border; a yellowish margin usually present on the front of the dorsal and anal and the outer part of the ventral. The dark spots are few in number below the lateral line. The ground color of the body is brownish or brownish black, varying with food and locality.

Names. In European countries in which this species is native it bears the name of trout or brook trout or the equivalents of these terms. In Germany it is *bachforelle;* in Italy, *trota;* in France, *truite.* In the United States it is known as the brown trout and von Behr trout, the latter in honor of Herr von Behr, president of the *Deutscher Fischerie Verein,* who has been very active in the acclimation of the fish in America.

Distribution. The brown trout is widely distributed in continental Europe and inhabits lakes as well as streams, specially in Norway and Sweden. Tributaries of the White sea, the Baltic, the Black sea and the Caspian contain this species. In Great Britain it lives in lakes and streams and has reached a high state of perfection: in Germany and Austria, however, the trout is a characteristic fish, and our supply has been drawn principally from the former country. Moreau found it at an elevation of 7000 feet in the Pyrenees, and a color variety is native to northern Algeria in about 37° north latitude. In the United States the brown trout has been successfully reared in Colorado at an elevation of nearly 2 miles above sea level; it is now well

established in New York, Pennsylvania, Maryland, Missouri, Michigan, Wisconsin, Nebraska, Colorado, and several other states. This trout has proved to be well adapted to the region east of the Rocky mountains, which has no native black spotted species, though the western streams and lakes contain many forms in a high state of development.

Size. Under favorable conditions the brown trout has been credited with a weight of 22 pounds and a length of 35 inches. In New Zealand rivers, where it was introduced with unusual success, it now approximates equal size; but in most localities 10 pounds is about the limit of weight and 5 or 6 pounds is a good average, while in some regions the length seldom exceeds 1 foot and the weight ranges from $\frac{1}{2}$ pound to 1 pound. In the United States a wild specimen, seven years old, weighed about 11 pounds. In a well in Scotland an individual aged 15 years measured only about 1 foot in length. These illustrations will serve to show how much the growth of a brown trout is affected by its surroundings and food supply. The species has been known to become sexually mature when two years old and 8 inches long.

Habits. The brown trout thrives in clear, cold rapid streams and at the mouths of streams tributary to lakes. In its movements it is swift, and it leaps over obstructions like the salmon. It feeds usually in the morning and evening, is more active during evening and night, and often lies quietly in deep pools or in the shadow of overhanging bushes and trees for hours at a time. It feeds on insects and their larvae, worms, mollusks and small fishes and, like its relative, the rainbow trout, it is fond of the eggs of fishes. In Europe it is described as rising eagerly to the surface in pursuit of gnats and is said to grow more rapidly when fed on insects.

Reproduction. Spawning begins in October and continues through December and sometimes into January. The eggs are from $\frac{1}{8}$ to $\frac{1}{5}$ of an inch in diameter and yellowish or reddish in color; they are deposited at intervals during a period of many days in crevices between stones, under projecting roots of trees, and sometimes in nests excavated by the spawning fishes. The

parents cover the eggs to some extent with gravel. The hatching period varies according to temperature from 40 to 70 days. Females aged three years furnish on the average about 350 eggs each, but individuals of this age have yielded as many as 700, and even at the age of two years some females produce from 400 to 500. When they are four or five years old, the number of eggs has reached 1500 to 2000. The young thrive in water with a temperature of about 50° F. Sterility in the females is common, and breeding females have been observed to cease reproduction when eight years old.

Qualities. The brown trout is in its prime from May to the last of September. Its flesh is very digestible and nutritious, and deeper red than that of the salmon when suitable food is furnished; the flavor and color, however, vary with food and locality. Insect food produces the most rapid growth and best condition. This species has been so long known as one of the noblest of the game fishes and its adaptability for capture with artificial flies because of its feeding habits is so well understood that I need not dwell on these familiar details.

The brown trout is remarkably hardy in captivity. A large female, received from Eugene G. Blackford in April 1896, and placed in a salt-water tank at the aquarium, lived there and throve till 1898. During most of the time the trout was in salt water, but at certain intervals fresh water was substituted for a short time, specially when symptoms of fungus made their appearance. In November 1896 she excavated a shallow depression in the gravel bottom and deposited a lot of eggs. The fish was extremely shy, and never lost its fear of the attendants. Liver and live killifish were used for its food.

A very beautiful and interesting hybrid is produced by crossing the brown trout and the brook trout. The following is a description of this hybrid:

Salmo (HYBRID=**fario**+**fontinalis**)

Hybrid Trout

In a paper published seven years ago the writer stated, as a result of his studies, that, when a large-scaled trout is crossed

with a small-scaled one, the hybrid will be large-scaled whichever way the cross be made. The hybrid between the brown trout and the brook is a large-scaled form, and it is sterile as far as reported. The aquarium has had this hybrid from the South Side Sportsmen's Club, and from the New York hatcheries at Cold Spring Harbor L. I. and Caledonia. It is always a strikingly handsome fish, and grows to a large size; but it is far less hardy than either of its parents. The cross has always been artificially made, and never occurs naturally. Two specimens studied gave the following measurements in inches:

MEASUREMENTS

	Caledonia N. Y. June 6 1895 James Annin jr	Oakdale N. Y. May 2 1895 G. P. Saile
Extreme length	9¼	14¼
Length of middle caudal rays from end of scales	¾	....
Depth of body	1⅞	3⅛
Least depth of caudal peduncle	⅞	....
Length of head	2	3¼
Length of snout	½	1⅛
Length of upper jaw	1¼	....
Length of lower jaw	1⅜	....
Diameter of eye	⅜	⅜
Distance from snout to dorsal origin	3¾	....
Length of dorsal base	1	....
Length of longest dorsal ray	1	....
Length of last dorsal ray	¾	....
Distance from snout to ventral origin	4½	....
Length of ventral	1⅛	....
Distance from snout to anal origin	6	....
Length of anal base	⅞	....
Length of longest anal ray	1¼	....
Length of last anal ray	½	....

The Caledonian specimen has no hyoid teeth; the vomerines are in a very small patch on the head of the bone only. The gill rakers are 4+10, the longest about one half the diameter of the eye. It has about 124 tubes in the lateral line. Branchiostegals. 10. The following color notes were taken from the fresh fish. Dorsal fin with numerous dark blotches resembling those of young rainbow; adipose long and slender, amber color with two obscure dusky blotches, one of these very indistinct; lower half of sides pink; ventral, anal and caudal pink; ventral and anal

with a milk white front margin, that in the anal limited behind by a dark line as in brook trout; sides reticulated with large meshes of lemon yellow interspersed with darker purplish or olive. Dorsal blotches are mingled with pale lemon. Pectoral pale vermilion. Eye silvery white with yellowish reflections.

The specimen from Oakdale L. I. weighed 20 ounces. It has a triangular patch of vomerine teeth, as found in fontinalis, but continued behind by several teeth in a single row, the entire length of the vomerine series being $\frac{5}{16}$ of an inch.

136 Salmo trutta levenensis (Walker)

Loch Leven Trout (Introduced)

Salmo levenensis Walker, Wern. Mem. I, 541, 1811; Yarrell, Brit. Fish. ed. 2, II, 117, 1841; ed. 3, I, 257, fig. 1859; Günther, Cat. Fish. Brit. Mus. VI, 101, 1866; Day, Fish. Great Brit. & Ireland, II, 92, pl. CXVI, fig. 2 & 2a, 1884; Baird, Rept. U. S. F. C. XII, LVIII, 1886.

Salmo trutta levenensis Jordan & Evermann, Check-List Fish. N. A. 512, 1896.

The Loch Leven trout of Great Britain was introduced into the United States from Scotland in 1885 and subsequent years. It is somewhat closely related to the European brown trout, Salmo fario, and has been artificially crossed with that species in the United States, so that it is sometimes difficult to find the pure bred Loch Levens in fish cultural establishments at home.

The body of the Loch Leven is more slender and elongate than that of the brown trout, its greatest depth contained four and one fourth to four and one half times in the total length without caudal. Caudal peduncle slender, its least depth three eighths of the greatest depth of the body, and equal to length of snout and eye combined. The head is rather short and conical, its length two ninths to one fifth of the total length without caudal. The snout is one fourth or slightly more than one fourth as long as the head. The interorbital space is somewhat convex, its width equal to three fifths of the length of postorbital part of head. The eye is of moderate size, its long diameter contained five and one half to six times in the length of the head, and equaling about twice the greatest width of the

maxilla. The maxilla reaches to or slightly beyond the hind margin of the eye. Teeth rather strong, those in the intermaxillary and mandible the largest, triangular head of vomer with two or three in a transverse series at its base, teeth on the shaft of the vomer usually in a single, partially zigzag, persistent series. Mandible without a hook and little produced even in breeding males. Dorsal origin distant from tip of snout about as far as end of dorsal base from base of caudal; the dorsal fin higher than long, its base one eighth of total length without caudal, its longest ray equal to longest ray of anal fin. The anal fin is much higher than long, its distance from the base of the ventral equaling length of the head. The ventral origin is nearly under the middle of the dorsal; the fin being as long as the postorbital part of the head. Pectoral equals length of head without the snout. Adipose fin very small, its width one half its length which is about equal to eye. Caudal fin emarginate unless fully extended, when it becomes truncate, the outer rays about one seventh of total length including caudal. D. 13 (— iv, 9); A. 12 (— iii, 9); P. 14; V. 9. Scales 24 to 28–118 to 130–26 to 30; pyloric caeca 47 to 90; vertebrae 56 to 59.

Upper parts brownish or greenish olive, or sometimes with a reddish tinge, sides silvery with a varying number of x-shaped black spots, or sometimes rounded brown spots or rounded black spots which may be ocellated; occasionally red spots are seen on the sides, and the adipose fin may have several bright orange spots, or it may show a red edge and several dark spots; sides of the head with round black spots; dorsal and adipose fins usually with numerous small brown spots; tip of pectoral blackish; anal and caudal fins unspotted, but the caudal sometimes has an orange margin and the anal a white edge with black at its base; a similar edge may sometimes be observed on the ventral.

The Loch Leven trout is a nonmigratory species, inhabiting Loch Leven and other lakes of southern Scotland and of the north of England. Its range in Great Britain and on the continent of Europe has been greatly extended by fish cultural

operations, and the fish is now fairly well known in the United States, though mixed to some extent with the brown trout, as remarked above.

The Loch Leven trout has been recorded of the weight of 18 pounds, but the average weight at 6 years of age is about 7 pounds, though some individuals of that age may reach 10 pounds. The natural food of this species includes fresh-water mollusks (snails, Buccinum, etc.), crustaceans, worms and small fish. In captivity it is reared on liver, horse flesh, chopped clams and various other meats.

As a food fish the Loch Leven is highly esteemed on account of the red color and the delicate flavor of its flesh when obtained from suitable waters; in some localities the flesh often becomes white from lack of food or improper food.

The spawning season may begin late in September or early in October and continue till December. In Michigan it corresponds with that of the brook trout. The egg varies from about $\frac{1}{5}$ to $\frac{1}{4}$ inch in diameter. A trout weighing 2 pounds contained 1944 eggs, the weight of which was $\frac{1}{2}$ pound.

The Loch Leven will take the artificial fly as readily as the brown trout and the brook trout. Its great size and strength add to its attractions for the angler.

137 Salmo irideus Gibbons

Rainbow Trout (Introduced)

Salmo irideus Gibbons, Proc. Cal. Ac. Nat. Sci. 36, 1855, San Leandro Creek, Alameda County, Cal.; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 312, in part, 1883; Bean, Bull. U. S. F. C. XII, 36, pl. V, figs. 2 & 3, 1894; Fishes Penna. 77, color pl. V, 1893; Ann. Rept. N. Y. Comm. Fish.; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. pl. LXXXI, fig. 216, 1900.

Salmo irideus shasta Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 502, 1896.

Body short and deep, its greatest depth equaling two sevenths of the total length without caudal. The least depth of caudal peduncle equals one half the length of head. The head is short and deep; its length is contained about four and two thirds times in the total length without the caudal. The snout is short,

not much longer than the eye, about one fourth the length of head. Diameter of the eye contained four and two thirds times in length of head; maxilla not quite reaching to below hind margin of eye; vomerines in two irregular series; gill rakers about 20. Dorsal origin a little nearer tip of snout than to caudal base. The length of the dorsal base is contained seven and one half times in total without caudal, and slightly exceeds longest dorsal ray; last dorsal ray one half as long as the longest. Ventral origin is under middle of dorsal base; the fin is as long as the longest dorsal ray; the ventral appendage about as long as the eye; when the ventral is extended, the distance of its tip from the vent is one third of length of head. The anal base is a little more than one half as long as the head; the longest anal ray equals the longest dorsal ray; the last ray is not quite so long as the eye. Adipose fin short, its width nearly equal to its length and two thirds of diameter of eye. B. 11; D. 11 divided rays and 4 rudiments; A. 10 divided rays and 3 rudiments. Scales 21–135 to 140–20.

The upper parts usually greenish blue, sometimes purplish; the sides more or less silvery and profusely spotted with small black spots, which are most numerous above the lateral line; head, dorsal, adipose, and caudal fins also black spotted. Sea-run specimens are uniform silvery without black spots. In the breeding season the broad crimson lateral band becomes brighter, and the sides of both sexes are iridescent purplish. The jaws of the male in the breeding season are not much distorted, but they are very much larger than in the female.

The rainbow trout is a native of the mountain streams of the Pacific coast and ranges from California to southern Alaska. A small example was taken at Sitka, in 1880, by Admiral L. A. Beardslee, U. S. N., and is now in the collection of the U. S. National Museum. This trout is found chiefly in mountain streams west of the Sierra Nevadas. It rarely descends into the lower stretches of the rivers, but occasionally does so and passes out to sea. The rainbow has been extensively introduced into many eastern states, but not with uniform success. In Wisconsin, Michigan, Missouri and North Carolina it has been

well acclimatized, and it is also fairly established in New York.

The average individuals of this species are less than 1 foot in length, but specimens measuring more than 2 feet and weighing 13 pounds have been recorded. At Neosho Mo. the young have been artificially grown to a length of nearly 1 foot in a year.

The rainbow feeds on worms, insect larvae and salmon eggs. In streams in which the California salmon and rainbow exist together, the rainbow is more destructive to the salmon eggs than any other species. Spawning takes place in winter and early spring, varying with temperature and locality. The bulk of the eggs are usually taken in January, February and March, and the average yield from each female is about 900 eggs. A few of the females spawn when two years old, but about one half of them begin at three years. The egg is from $\frac{1}{5}$ to $\frac{2}{9}$ inch in diameter; it has a rich cream color when first taken, changing to pink or flesh color before hatching.

The rainbow will live in water of a much higher temperature than the brook trout will endure and it thrives in tidal streams and even in salt water. On Long Island, for example, the South Side Sportsmen's Club obtains a great deal of fine sport with this trout in the estuary of its trout brook. The flesh of the rainbow is generally much esteemed, and in most localities the game qualities of the fish are scarcely inferior to those of the brook trout.

Large rainbow trout do not stand transportation well when ice is used to cool the water in which they are carried. They frequently injure their eyes, and become blind soon after the end of a journey. They are inveterate fighters, and the strongest invariably rules and harasses the rest. Contrary to what has been stated heretofore, they will not endure high temperatures as well as the brook trout, at least in the aquarium.

138 Salmo lemanus Cuvier

Swiss Lake Trout (Introduced)

Salmo lemanus Cuvier, Régne Anim. *fide* Günther; Günther, Cat. Fish. Brit. Mus. VI, 81, 1866.

Salmo trutta Jurine, Mém. Soc. Phys. Genève, III, 1, 158, pl. 4, 1825.

Fario lemanus Cuvier & Valenciennes, Hist. Nat. Poiss. XXI, 300, pl. 617 (male) 1848.

Swiss lake trout Atkins, Rept. U. S. F. C. XVII, XVIII, XIX, 1893 and 1894.

Head well proportioned in its shape, of moderate size, body rather stout; preoperculum with a distinct lower limb, operculum rather broad and high; snout of moderate length, rather produced in the male sex, in which a mandibular hook is developed in the spawning season; maxillary longer than the snout, and at least as strong and broad as in S. f a r i o; in specimens 12 inches long it extends somewhat behind the vertical from the hind margin of the orbit. Teeth moderately strong, those on the vomer in a single series, alternately bent toward the right and left, persistent throughout life. Pectoral fin rounded, its length being less, and in young individuals more than, one half of its distance from the ventral. The caudal becomes truncate with age; in specimens of from 12 to 15 inches in length it is emarginate, the middle rays being half as long as the outer ones. The hind part of the body of moderate depth; there are 13 or 14 scales in a transverse series descending from behind the adipose fin forward to the lateral line.

Back greenish, sides and belly silvery, numerous very small X-shaped black spots on the sides; opercles and dorsal fin with numerous black dots; the other fins greenish. D. 13; A. 12; P. 14; V. 9. Scales 26 to 28–115 to 128–36; pyloric caeca 45–52; vertebrae 57 (once), 58–59. (After Günther)

Attempts have been made from time to time to introduce into large, cold lakes of the United States the fine lake trout of Lake Geneva, Switzerland. Eggs have been furnished to the U. S. Fish Commission by the Swiss government, and these were hatched at the Craig brook (Me.) station, and from there the young were distributed to lakes believed to be suitable for the experiment. In New York, the Adirondack League Club obtained 1000 of the young of this species in 1896 and deposited them in Green lake, in Herkimer county. The specimen described below is probably one of the results of that experiment. Swiss lake trout were furnished also to the New York Fish Com-

mission for planting in Lake George, and 100 yearlings were presented to the New York aquarium.

A specimen taken in Green lake, Adirondack League Club preserve, Herkimer co., July 29, 1899, was forwarded to the U. S. Fish Commission, Washington D. C., and there described by Dr W. C. Kendall, from whose notes the following account is drawn.

The total length of the specimen is $11\frac{3}{8}$ inches. When first taken it was reported to measure $11\frac{3}{4}$ inches. The body is moderately elongate, its greatest depth contained three and three fifths times in the total length to base of caudal. Head large, slightly more than one third of total length to base of caudal; eye rather large, about one fifth of length of head; snout long, about three tenths of length of head; teeth on jaws, palatines and tongue long, curved and sharp, those of the lower jaw longest, shaft of vomer long with a zigzag row of sharp teeth; gill rakers short, the longest one third of diameter of iris, 4 – 11 on right side, 5 + 10 on left side. Hight of longest dorsal ray two thirds of length of head. Pectoral five eighths as long as the head. B. 11–12; D. ii, 9; A. i, 8. Scales in lateral line 115.

General appearance of Salmo salar sebago, from which it would probably not be distinguished by the casual observer if caught where the landlocked salmon occurs; but the lemanus is distinguishable by the heavier appearance forward of the dorsal fin.

Color in spirits, brownish on back, top of head and sides of head; sides and belly very silvery; large roundish black spots above lateral line forward and on cheeks and opercles; perpendicularly elongate spots forward below lateral line; black of all spots most intense on edges of scales; posteriorly the spots show only on the edges of the scales, being variously crescentic, double or triple crescentic, X or double X shaped; fins pale with slightly dusky tinge; dorsal with 5 transverse rows of black spots.

Mr De Witt, who sent the specimen, furnished the following notes on Green lake, from whence it was forwarded. "Maximum depth 42 feet, with temperature at bottom at that depth, as far as I have been able to ascertain, about 40°. Has no

outlet so far as we know. No brown trout have ever been put in it, and we take it for granted that the specimen I send is one of the 'Swiss trout.'"

Genus CRISTIVOMER Gill & Jordan

This genus contains one or two species, large, coarse chars, distinguished from Salvelinus by the presence of a raised crest behind the head of the vomer and free from the shaft; this crest is armed with teeth. The hyoid teeth constitute a strong, cardiform band. The typical species is a large char or trout, spotted with gray instead of red, and found in the larger lakes of eastern North America. (After Jordan and Evermann)

The species namaycush is found also in a lake (Henry) in Idaho, in the Columbia river basin, and northwestward to northern Alaska.

139 Cristivomer namaycush (Walbaum)

Lake Trout; Salmon Trout

Salmo namaycush WALBAUM, Artedi. Gen. Pisc. III, 68. 1792. Hudson Bay, based on the Namaycush Salmon of Pennant; RICHARDSON, Fauna Bor.-Amer. III, 179, pl. 79 & pl. 85, fig. 1, 1836, Great Lakes; THOMPSON, Nat. Hist. Vermont, I, 140, figure, 1842; KIRTLAND, Bost. Jour. Nat. Hist. IV, 25, pl. III, fig. 2, 1844; GÜNTHER, Cat. Fish. Brit. Mus. VI, 123, 1866.

Salmo pallidus RAFINESQUE, Amer. Month. Mag. II. 120, December, 1817. Lake George, Lake Champlain and other lakes; not ascending brooks.

Salmo amethystinus MITCHILL, Jour. Ac. Nat. Sci. Phila. I, 410, 1818.

Salmo hoodii RICHARDSON, op. cit. 17, pl. 82, fig. 2, pl. 83, fig. 2, 1836.

Salmo confinis DE KAY, N. Y. Fauna, Fishes, 238, pl. 38, fig. 123, 1842.

Salmo amethystus DE KAY, op. cit. 240, pl. 76, fig. 241.

Salmo adirondacus NORRIS, American Angler's Book, 255, 1865.

Salmo siscowet GUNTHER, Cat. Fish. Brit. Mus. VI, 124, 1866.

Salvelinus namaycush JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 317. 1883; GOODE, Fish. & Fish. Ind. U. S. I, 485, pl. 191B, 1884; BEAN, Fishes Penna. 82, color pl. 8, 1893.

Cristivomer namaycush JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 504. 1896, pl. LXXXII, fig. 217, 1900; BEAN, Bull. Amer. Mus. Nat. Hist. IX, 348, 1897.

The lake trout or Namaycush has a stout and moderately elongate body. The caudal peduncle is slender; its hight little more than one third of the greatest hight of the fish. The eye is large, placed near the top of the head, two thirds as long as

the snout, and contained four and a half to five and a half times in length of head. The maxilla reaches far behind the eye; its length nearly half that of head. The origin of the dorsal is midway between tip of snout and root of tail. The length of the base equals length of maxilla; its longest ray one sixth of total without caudal. The ventral is under the hind part of dorsal; its length half the length of head. The appendage is very short, about half the length of eye. The fin, when extended, reaches nearly to the vent. The distance between ventral origin and anal origin is one fifth of total length without caudal. The anal base is about one third of length of head; the longest ray half of length of head; the last ray equal to eye. The pectoral is nearly two thirds as long as the head. B. 11 to 12; D. 9 to 10 besides several rudiments; A. 9 and several rudiments; V. 9. Scales of lateral line about 200.

The coloration is extremely variable, generally grayish, in the variety known as the tuladi, nearly black. Alaskan specimens are usually very dark; occasionally the upper parts are pale. The sides are profusely covered with roundish pale spots, sometimes with a reddish tinge. On the back and top of head there are fine vermiculations resembling those of the brook trout. The caudal in addition to numerous pale spots has many small dark blotches.

The lake trout has received many names, among which are the following: Mackinaw, Namaycush, togue, tuladi, and salmon trout. Additional names of the species are lunge, red trout, gray trout, and black salmon. Togue and tuladi are names applied in Maine, New Brunswick and Canada; Mackinaw and salmon trout in the Great lakes region, the latter used also in New York. Namaycush is of course an Indian name.

The lake trout is native in the Great lakes region, lakes of New York and New England, Idaho and northward into Labrador, British America and Alaska. Extending over such a wide range of country, it varies greatly in size, form and color, which will in part account for the various names which it has received. It has been found above the Arctic circle in Alaska.

This is one of the largest species of the salmon family resident in fresh waters. It reaches a length of 3 feet, and specimens weighing 40 pounds are not uncommon. It is said that an example of 90 pounds and 6 feet in length has been taken. The species is found in its best condition in Lakes Huron, Michigan and Superior. In Alaska it grows to a large size, and is a very shapely and beautifully colored fish.

The lake trout is one of the most rapacious fishes of its family. In Lake Michigan it feeds largely on the cisco and other small whitefishes. At Two Rivers Wis. a lake trout measuring 23 inches was found to contain a burbot about 17 inches long. The gluttony of this species is proverbial. It will devour table refuse, and materials of this kind have frequently been taken from its stomach. Even twigs, leaves and pieces of wood have been taken by this trout. The species is much more sluggish in its habits than the brook trout, and is taken on or near the bottom. The gill and pound nets in which this species is principally captured are set in deep water.

The spawning of the lake trout usually begins in October and continues into November. For this purpose they come up on rocky shoals and reefs in depths of from 70 to 90 feet, and spawn near the edges of rock caverns, into which the eggs settle. The young are hatched late in the winter or early in spring. In some localities the depth of the spawning areas ranges from 15 fathoms to only 7 feet. Mr Milner found 14,943 eggs in a lake trout weighing 24 pounds. In the hatchery, with a water temperature of 47°, the young hatch about the last week of January, but their hatching may be retarded several weeks by lower temperatures.

The fishery for the lake trout is most active in September, October and November, and the fish are taken chiefly in pound and gill nets. In some regions many of them also are caught with hooks. In Lake Erie a few large trout of this species weighing from 25 to 40 pounds are taken off the city of Erie. In 1885, according to the statistics of the U. S. Fish Commission, 100,000 pounds of lake trout were taken in Erie county, Pa.

The only New York examples of lake trout were received from James Annin jr, Caledonia, in the fall of 1896. They lived and grew rapidly till the warm water killed them in June 1897. They could not endure transfer to salt water of a lower temperature, as so many other trout will do, and nothing else could be utilized to tide them over till the completion of the refrigerating plant.

Owing to the extensive individual and race variation among trout referred to this species, it seems desirable here to give some notes and measurements made from individuals obtained from New Hampshire and Vermont. Two lake trout weighing about 4¾ pounds each were shipped in a can only a few inches longer than the fish, from Roxbury Vt. November 17, and, after an express journey of 20 hours without an attendant, one of them survived in good condition, while the other was nearly dead on arrival and died within one hour. The latter was a female, and appears to have injured itself severely by jumping in the can; it was not in good condition when it left Vermont. 12 large brook trout shipped with the lake trout in two cans arrived without injury; these and the lake trout were presented by John W. Titcomb, Fish and Game Commissioner.

Commissioner N. Wentworth of Hudson Center N. H. forwarded the New Hampshire lake trout, one from Newfound lake, the other from Lake Winnepesaukee. They were sent to determine whether the trout of the two lakes, which the fishermen assert are different species, really are distinct. The commissioner wrote that "the Newfound trout has darker flesh, more like the sea salmon. This is not caused by their food, as both lakes are alive with smelt. The Winnepesaukee lake trout are better biters; tons of them are caught through the ice every winter. The Newfound trout are hardly ever caught through the ice. A few were caught last winter for the first time to my knowledge. I am sure there is but one variety of lake trout in Newfound lake. We had one in our tanks this fall that would weigh 25 pounds." The only differences to be found on examination were such as relate to the depths at which

the two races habitually live; one is the slim, dark colored tuladi, and the other the common lake trout of the Great lakes region.

It is necessary, however, to call attention to the lake trout from northern Vermont which furnished one of the series of measurements given below. The gill rakers in that example are few in number and unusually short, four or five on each side being reduced to mere spiny tubercles.

The following table gives dimensions in inches.

MEASUREMENTS

	Newfound lake ♂	Winnipiseogee lake ♂	Roxbury Vt. ♀
Length, including caudal	24½	27⅛	22
Length to base of middle caudal rays	21	23⅝	19½
Least depth of caudal peduncle	1⅝	1⅞	....
Greatest depth of body	4⅝	6⅜	4½
Thickness of body	2¾	2⅝	2¾
Length of head	5⅜	6½	4¼
Length of snout	1¼	1¾	1⅛
Length of postorbital part of head	3¼	3⅞	2½
Length of upper jaw	2¾	3⅞	2⅜
Length of maxilla	2¼	3	2
Diameter of eye	¾	¾	⅝
Interorbital width	1⅝	2⅜	1⅛
Distance from snout to dorsal	10¾	12⅝	10
Length of dorsal base	2⅝	2½	2⅛
Length of longest dorsal ray	3	2¾	2⅜
Length of last dorsal ray	1½	1⅜	1⅛
From end of dorsal to adipose fin	4½	5	4¼
Length of adipose fin	¾	1	¾
Width of base of adipose fin	⅜	⅜	⅜
Distance from snout to ventral	12¼	14⅜	11⅝
Length of longest ventral ray	2⅝	2⅞	2⅜
Length of last ventral ray	1⅜	1½	....
Length of ventral appendage	¾	⅜	⅝
Distance from snout to anal	16	18⅝	15½
Length of anal base	2	2⅜	1⅞
Length of longest anal ray	2¾	2½	2½
Length of last anal ray	1	1	¾
Length of pectoral	3½	3½	3¼
Length of upper caudal lobe	3¾	3¾	....
Length of lower caudal lobe	3½	3⅞	....
Length of longest gill raker	⅛	⅛	⅛

In the Newfound lake fish we have:

B. 11; D. 11; A. 10 (counting divided rays only); V. i, 8; P. i, 12. Scales 26–195–34 (about 150 tubes); gill rakers, 9+13, the longest a little more than one half the length of eye, the one in the angle club-shaped at the tip. It is a male with spermaries moderately small but soft. The body is gray, darker on the back. The outer edge of the pectoral and ventral and the front margin of the anal are white as in f o n t i n a l i s. A white tip to the lower caudal lobe and a very small one at the top of the dorsal. Otherwise the coloration is like that of ordinary lake trout, which have the pectoral, ventral and anal chiefly vermilion in the breeding season.

The male from Winnepesaukee lake has:

B. 12 to 13; D. 10; A. 10; V. i, 8; P. 12. Gill rakers 8+12, the longest about one half as long as the eye. The ground color is a little lighter than in the Newfound lake trout, and the vermilion of the pectorals, ventrals and anal is less intense. The spermaries are larger than in the specimen from Newfound, and in about the same stage of development; the body is considerably stouter.

The female from Roxbury Vt. shows the following additional characters.

B. 12; D. 10; A. 10; V. i, 8. Gill rakers 8+12, the longest exactly one half as long as the eye. The eggs and ovaries are small as in young females. The pectorals, ventrals and anal are chiefly vermilion, as in the male from Newfound lake. The body is silvery gray with numerous small, whitish spots, these present also on the dorsal.

Hon. H. W. Sage is authority for the information that the lake trout was formerly common in the lake near Ithaca. About 1830 a large individual was found stranded in Cayuga lake inlet, about 1½ miles from the lake.

Genus SALVELINUS (Nilsson) Richardson

Body moderately elongate; mouth large or small; teeth of jaws, palatines, and tongue essentially as in S a l m o, the hyoid patch present or not; vomer boat-shaped, the shaft much de-

pressed, without raised crest, with teeth on the head of the bone and none on the shaft; scales very small, 200 to 250 in a lengthwise series; fins moderate, the caudal forked in the young, truncate in some species in the adult; sexual peculiarities not strongly marked, the males with the premaxillaries enlarged and a fleshy projection at the tip of the lower jaw. Coloration dark, with round, crimson spots, the lower fins sometimes with marginal bands of black, reddish, and pale. Species numerous in the clear streams and lakes of the northern parts of both continents, sometimes descending to the sea, where they lose their variegated colors and become nearly plain and silvery. The members of this genus are by far the most active and handsome of the trout, and live in the coldest, clearest and most secluded waters. (After Jordan and Evermann)

140 Salvelinus fontinalis (Mitchill)

Brook Trout

Salmo fontinalis Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 435, 1815, near New York; Richardson, Fauna Bor.-Amer. III, 176, pl. 83, fig. 1, 1836; De Kay, N. Y. Fauna, Fishes, 235, pl. 38, fig. 120, 1842; Günther, Cat. Fish. Brit. Mus. VI, 152, 1866.

Salmo canadensis Hamilton Smith in Griffith's Cuvier, X, 474, 1834, Canada.

Salmo immaculatus H. R. Storer, Bost. Jour. Nat. Hist. VI, 364, 1850, Lower St Lawrence.

Salmo erythrogaster De Kay, N. Y. Fauna, Fishes, 236, pl. 39, fig. 136, 1842.

Baione fontinalis De Kay, op. cit. 244, pl. 20, fig. 58, 1842.

Salvelinus fontinalis Jordan, Proc. U. S. Nat. Mus. I, 81, 1878, in part; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 320, 1883; Goode, Fish & Fish. Ind. U. S. I, 497, pl. 192, 1884; Bean, Fishes Penna. 80, color pl. 7, 1893; Bull. Amer. Mus. Nat. Hist. IX, 350, 1897; Bowers, Manual Fish Cult. ed. 2, color pl. frontispiece, 1900; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 506, pl. LXXXII, fig. 218, 1900.

The brook trout varies greatly in the shape of the body, which is sometimes short and deep and again elongate and moderately thin. The depth is usually about one fourth or two ninths total length without caudal, and is about equal to length of head. The least depth of the caudal peduncle is a little more than one third of its greatest depth. The head is large and the snout somewhat obtuse. The eye is in front of the middle of its length, a little more than one half as long as the snout, and about one

sixth of length of head. The dorsal fin is about midway between tip of snout and root of tail. The length of its base equals about half its greatest depth of body. The longest ray equals length of ventral. The ventral origin is a little behind the middle of the dorsal. In the male, when laid backward, it reaches nearly to the vent. The length of the appendage equals that of the eye. The anal base is two thirds as long as the ventral, its longest ray equal to ventral. The adipose fin is short and stout, its width two thirds of its length and about two thirds of length of eye. D. 10; A. 9. Scales in lateral line 225 to 235; six gill rakers above the angle of the first arch; 11 below.

The coloration is highly variable with age and locality. The upper parts are usually grayish much mottled with dark olive or black. The dorsal fin and anterior part of caudal base and top of head are also mottled. The caudal has narrow dark bars. The lower fins dusky with a creamy white interior edge bound behind by a narrow black streak. On the sides numerous pale brownish blotches encircle small vermilion spots.

The brook or speckled trout of the east is indigenous to the region east of the Alleghany mountains and the Great lakes region, extending from North Carolina on the south to Labrador on the north. The distribution of this trout has been wonderfully extended by artificial introduction, as it has always been a favorite with fish culturists. It is now to be found thriving in many of the western states and territories, and is particularly thrifty in Nebraska, Colorado, Nevada, and California. It has also been sent to Mexico and to European countries. The average brook trout seldom exceeds 7 or 8 inches in length, and smaller individuals are much more abundant and require legal protection. In the northeastern part of its habitat the brook trout grows much larger, specimens weighing from 3 to 6 pounds being not uncommon; and in one of the Rangeley lakes an individual weighing 11 pounds is recorded; while Seth Green took a 12 pound specimen in the Sault Ste Marie, and Hallock mentions one which was said to weigh 17 pounds.

The brook trout does not flourish in water warmer than 68°, and prefers a temperature of about 50°. It is an inhabitant of the cold, clear mountain streams, and will leave a region which becomes polluted by mill refuse and other hurtful substances. In the Long Island region and around Cape Cod, where the brook trout has free access to salt water, it has the habit of going to sea in the fall and remaining during the winter. It then grows rapidly and becomes a much more beautiful fish than many which live exclusively in fresh water. In hot weather, when the temperature of the streams becomes too high and lakes are accessible, trout seek the deep parts of the lakes and the vicinity of cold springs. In streams they are to be found in deep pools or in channels. They feed in spring and early summer among the rapids on insects and small crustaceans.

The brook trout is a nest-builder. Cavities are made in the gravel, and the nest is shaped with the tail, and the larger stones are carried in the mouths of the parents. After the eggs are deposited, they are covered with gravel. The eggs are not all deposited at one time. Spawning usually begins in October, but brook trout are spawning at some locality in almost every month of the year except midsummer. The egg is about $\frac{1}{5}$ inch in diameter, and varies in color from pale lemon to orange red. The average yield of the female is from 400 to 600. Livingston Stone has taken 1800 from a fish weighing 1 pound.

The period of hatching will depend on the temperature, ranging from 165 days in water of 37° to 32 days in water of 54°. The yolk sack is absorbed in from 30 to 80 days, and after its absorption the young fish begin to feed. The rate of growth will of course depend on the amount of food consumed. In artificial culture yearlings, according to Mr Ainsworth's estimate, will average 2 ounces; fish of two years 4 ounces; of three years, 8 ounces, and of four years, 1 pound.

The value of the brook trout as a food fish and its game qualities are so well known that I need hardly refer to them here.

The brook trout is well adapted to domestication in aquarium tanks; it soon overcomes its fear of moving objects, takes its

food regularly, and is always attractive because of its beauty and graceful movements. It will live in fresh and salt water. When it is attacked by fungus in fresh water, the parasite is easily killed by introducing salt water, gradually increasing in salinity, and the trout is not at all injured or inconvenienced by the treatment. In captivity the food consists almost entirely of chopped hard clams and liver for the young, while hard clams, live killifish and occasional earthworms are given to the large fish. The increase in size with such feeding is remarkable. A brook trout, from Caledonia N. Y., not more than 3½ inches long in November 1896, measured 12¼ inches in length and 3½ inches in depth Dec. 10, 1897.

A single young brook trout from Caledonia survived in water at 76° F but that temperature was generally fatal to the species.

Dr Meek has found the trout in small streams on the uplands throughout the Cayuga lake basin.

Mitchill knew this fish chiefly as an inhabitant of Long Island waters, and has given an interesting account of the fishing at Nichols, Patchogue and Fire Place, where a Mr Robbins, in 12 days in the summer of 1814, caught 190 trout weighing 139 pounds, 11 ounces. The largest at Patchogue weighed 2½ pounds, the largest at Fire Place, 3 pounds. A Mr Purvis, of New York, caught a trout measuring 24 inches and weighing 4½ pounds at Fire Place.

At that time, according to Mitchill, the trout was "bought at the extravagant price of a quarter of a dollar for a single fish not more than 10 or 12 inches long," and New York anglers traveled "away to Hempstead and Islip for the pleasure of catching and eating him."

141 Salvelinus alpinus (Linnaeus)

Saibling (Introduced)

Salmo alpinus Linnaeus, Syst. Nat. ed. X, I, 309, 1758, Lapland, West Gothland.

Salmo salvelinus Linnaeus, op. et loc. cit. Lintz in Austria.

Salmo salmarinus Linnaeus, op. cit. 310, 1758.

Salmo umbla Linnaeus, op. cit. 310, 1758, Lakes of Switzerland and Italy.

Salmo ascanii Cuvier & Valenciennes, Hist. Nat. Poiss. XXI, 256, 1848, Norway.

Salmo rivalis GAIMARD, Voyage en Island, Groenland, pl. 15, 1851, Iceland.
Salmo willughbii GÜNTHER, Proc. Zool. Soc. 46, 1862, Lake Windermere.
Salmo grayi GÜNTHER, Proc. Zool. Soc. 51, 1862, Lough Melvin, Ireland.
Salmo colii GÜNTHER, Proc. Zool. Soc. 12, 1863, Lough Esk.
Salmo perisii GÜNTHER, Ann. & Mag. Nat. Hist. XV, 75, 1865, North Wales.
Salmo killinensis GÜNTHER, Proc. Zool. Soc. 699, 1865; Loch Killin, Inverness.
Salvelinus alpinus BEAN, Proc. U. S. Nat. Mus. Sterling Lake, New York & New Jersey; JORDAN & EVERMANN, Check-List Fish. N. A. 293, 1896; and Bull. 47, U. S. Nat. Mus. 508, 1896.

Salvelinus alpinus (Linnaeus)

Sälbling; Saibling (Introduced)

Body moderately elongate, compressed, its greatest depth two ninths of total length to caudal base; the caudal peduncle short and stout, its least depth two fifths of length of head; head rather short, its length contained from four and one third to four and one half times in total length to base of caudal (middle caudal rays). The body is somewhat elevated at the nape and for a short distance behind it. Mouth large, the maxilla reaching somewhat behind eye, its greatest width less than one fourth of its length, the upper jaw one half as long as the head; eye rather large, nearly equal to snout, one fifth of length of head; interorbital space convex, one and one half times diameter of eye; lower jaw very slightly projecting; vomerine teeth in a very small patch on the head of the bone, lingual teeth strong, teeth on both jaws well developed, those of the mandible strongest; gill rakers short, straight, very slender, the longest one half as long as the eye, 11 above and 14 below the angle of the first arch.

The dorsal origin is nearer to tip of snout than to base of caudal, its distance from the snout equaling twice the length of head; the dorsal base is as long as the postorbital part of head; the longest dorsal ray is two thirds as long as the head, and nearly twice as long as the last ray. Adipose fin twice as long as wide, as long as the iris, its origin distant from base of middle caudal rays a space equal to length of head without the snout; the fin is over the end of anal base. Ventral midway between tip of snout and base of middle caudal

rays, its length two thirds of length of head; its appendage as long as the eye. Anal fin distant from ventral origin a space equal to length of head; anal base as long as snout and eye combined; longest anal ray equal to ventral and nearly two and one half times last anal ray. Pectoral as long as the head without the snout. Caudal well forked, its outer rays about as long as the pectoral fin.

Color of the upper parts dark gray or greenish, the sides with a silvery shade passing into a deep red or orange on the lower half and, specially, the belly; red spots on the sides; lower fins margined with white and a blackish shade within the margin; sides of the head silvery; dorsal and caudal fins uniform dusky, unspotted.

The saibling has been introduced into the United States, and a specimen was obtained from Sterling lake, N. J., Dec. 29, 1888. This was presented by A. S. Hewitt jr to Eugene G. Blackford of New York city, and by him forwarded to the U. S. National Museum for identification and preservation. The specimen is $9\frac{3}{5}$ inches long. It does not differ in any way from European specimens with which it has been compared, as may be seen from the following description.

The greatest hight of the body equals two ninths of the total length without caudal; the least hight of the caudal peduncle is two fifths of greatest depth of body and one third of length of head. Head large, one fourth of total length without caudal; snout equal to eye, four in head; maxilla extending to slightly behind orbit, its width nearly one fourth of its length; mandible slightly projecting. Dorsal origin nearer to tip of snout than to base of caudal; base of dorsal one half as long as the head; longest dorsal ray equal to pectoral and nearly two thirds of length of head; last dorsal ray one third of length of head. Adipose fin over the last two or three anal rays, its length about equal to diameter of iris. The ventral origin is under the fifth or sixth divided ray of the dorsal; the fin is as long as the postorbital part of the head; its appendage is not quite one third as long as the fin, and equals the diameter of the iris.

The anal base is four ninths as long as the head; the last ray of the fin is one half as long as the longest, which is one half as long as the head. The pectoral reaches almost to below the origin of the dorsal, its length two thirds of length of head. Caudal deeply forked, its middle rays less than one half as long as the outer, which are equal to length of head without the snout.

The fish is an immature male with about 10 oblong parr marks on the sides and with a few narrow dark blotches simulating half bands on the back from near the nape to a point behind the dorsal fin; numerous pale spots along the middle of the sides, each of which no doubt had a vermilion spot in the center in life.

Sterling lake is in New York and New Jersey; and it was stated that the trout are found in streams emptying into the lake. This is noteworthy as being the only instance, as far as known, of successful introduction of the saibling into our waters.

142 Salvelinus alpinus aureolus (Bean)

Sunapee Trout; Golden Trout; Silver Trout (Introduced)

Salvelinus aureolus Bean, Proc. U. S. Nat. Mus. 628, 1887. Sunapee Lake, New Hampshire.

Salvelinus alpinus aureolus Jordan, Forest & Stream, Jan. 22, 1891; Quackenbos, Trans. N. Y. Ac. Sci. XII, 139, 1893; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 511, 1896, pl. LXXXIII, fig. 220, 1900.

Salmo alpinus Garman, American Angler, Feb. 5, 1891.

The type of the description, no. 39334, was obtained in Sunapee lake, N. H., in the fall of 1887 by Dr John D. Quackenbos.

The length of the specimen to the caudal base is $6\frac{2}{5}$ inches. The greatest hight of the body equals the length of the head, and is contained about four times in the total without caudal. The least hight of the tail equals one third the length of the head. The maxilla reaches past the middle, but not to the end of the eye; its length is contained about two and two thirds times in length of head. The length of the upper jaw is contained about two and one third times in the length of the head, and is equal to the longest anal ray. The eye is a little longer than

the snout, and is contained four and two seventh times in the length of the head. Hyoid teeth well developed. The first dorsal is a little nearer the tip of snout than to the base of caudal, and the length of its base is one half the length of the head. The adipose dorsal is distant from end of first dorsal a space equal to twice the length of the ventral. The anal is at a distance from the snout equal to about three times the length of the head. The longest anal ray is equal to the length of the upper jaw. The length of the middle caudal rays is equal to twice the diameter of the eye. The ventral is situated midway between the tip of the snout and caudal base; its length equals one half the length of the head. The length of the pectoral is about twice the width of the interorbital area. B. 10; D. iv, 9; A. iii, 8; P. 13; V. 9. Scales 35–210–40; gill rakers 6+10–12. The peculiarity of the gill rakers of this trout is that they are always curled up at the ends and not straight, as in the oquassa from Maine.

Sides silvery white. Back with about six well defined bandlike markings, besides some irregular dark blotches. There are about 10 parr marks on the sides, and numerous small, roundish, white spots. In colors this char is different from the oquassa from Maine, but, if fresh specimens of the Maine trout were compared with this young fish, the difference in color might not be so great.

The specimen described is a young male with the spermaries showing as a mere slight ribbon. Its stomach contained an earthworm and the wing cases of a squash beetle. The other two specimens (somewhat smaller) are females far from maturity.

In a female, no. 37408, 11 inches in total length, both parr marks and bands across the back show very plainly. This female has a few free eggs in the abdominal cavity and seems to be nearly spent. In examples of this size the tail is deeply forked, the middle rays being less than one half as long as the external rays.

In males the pectoral is always longer than in females of equal size.

The following color notes were taken from nos. 38321 to 38328, collected by Col. Hodge in Sunapee lake, Dec. 10, 1886. Head and upper parts brownish gray, caudal the same, with the exception of a narrow white margin on the lower lobe; under surface of head, in most examples, brownish gray, in others whitish; belly orange, this color extending up on the sides but not to the middle line of the body; anal orange, with white margin in front; ventrals orange, with broad white margin on the outer rays; pectorals, gray upper half, and orange lower half; dorsal gray, lighter along the base; sides, both above and below lateral line, with numerous orange spots, fading out to whitish. The largest of these spots are little more than one third as long as the iris. No mottlings anywhere.

MEASUREMENTS

Current number of specimen	37408 ♀		39334 ♂	
Locality	SUNAPEE LAKE, N. H.		SUNAPEE LAKE, N. H.	
	Millimeters	100ths of length	Millimeters	100ths of length
Length to base of caudal	257	100	160	100
Body:				
Greatest hight	51	20	38	23½
Greatest width	25	9½	....	....
Hight at ventrals	49	19	36	22
Least hight of tail	21	8	13	8
Length of longest gill raker	4	1½	2	1⅛
Head:				
Greatest length	54	21	38	23½
Distance from snout to nape	36	14	27	16⅔
Greatest width	24	9	18	11
Width of interorbital area	18	6⅔	11	6½
Length of snout	11	4	7	4
Length of operculum	13	5	....	....
Length of maxillary	21	8	14	8⅛
Length of upper jaw	25	9½	16½	10
Length of mandible	31	12	21	13
Distance from snout to orbit	13	5	8	5
Diameter of orbit	13	5	11	6½
Diameter of iris	9	3½	8½	5
Dorsal (first):				
Distance from snout	112	43½	76	47
Length of base	28	11	19	11⅔
Length of longest ray	32	12½	21	13
Length of last ray	15	5⅔	12	7⅛

MEASUREMENTS

Current number of specimen	37408 ♀		39334 ♂	
Locality	SUNAPEE LAKE, N. H.		SUNAPEE LAKE, N. H.	
	Millimeters	100ths of length	Millimeters	100ths of length
Dorsal (soft):				
From origin of first	90	35	60	37½
Length along hind margin	9	3½	6	3⅜
Length of base	5	2	3	1⅞
Anal:				
Distance from snout	183	71	117	73
Length of base	22	8⅓	15	9
Longest ray	28	11	16½	10
Last ray	13	5	8	5
Caudal:				
Length of middle rays from end of scales	18	6⅞	13	8
Length of external rays	41	15⅞	32	19⅞
Pectoral:				
Distance from snout	53	20½	36	22
Length	37	14⅓	24	14⅔
Ventral:				
Distance from snout	127	49	84	52½
Length	31	12	20	12½
Length of appendage	14	5⅓	8	5
Branchiostegals	10	....	10	....
Dorsal	9	....	9	....
Anal	8	....	8	....
Pectoral	....	....	13	....
Ventral	I, 8	....	I, 8	....
Number of scales in lateral line	....	....	210	....
Number of transverse rows above lateral line	34	....	35	....
Number of transverse rows below lateral line	38	....	40	....
Number of gill rakers	$\frac{7}{12}$	....	$\frac{6}{10}$–12	....
Number of caecal appendages	[a]39	....	....	....

The golden trout is a native of Sunapee lake and Dan Hole pond, in New Hampshire, and of Flood's pond, in Maine. Doubtless it exists in other lakes of New England and British North America.

It is a large species, reaching a length of 20 inches and the weight of 6 or 8 pounds; even larger individuals have been reported. Spawning takes place in Sunapee lake on reefs in shallow water and not in the streams tributary to the lake; the

[a] In a , 37409.

season is about the same as for the brook trout. The colors of the male in the breeding season are gorgeous, and the sight of a host of spawning fish in the water is one to be remembered.

Many large and small trout of this kind have been deposited in Lake George and other suitable waters of the state.

Family ARGENTINIDAE

Smelts

Genus OSMERUS (Artedi) Linnaeus

Body elongate, compressed; head long, pointed; mouth wide, the slender maxillary extending to past the middle of the eye, lower jaw projecting, preorbital and suborbital bones narrow; maxillaries and premaxillaries with fine teeth, lower jaw with small teeth, which are larger posteriorly, tongue with a few strong, fanglike teeth, largest at the tip, hyoid bone, vomer, palatines and pterygoids with wide set teeth; gill rakers long and slender; branchiostegals 8; scales large, loose, 60 to 70 in the course of the lateral line; dorsal small, about midway of the body, over the ventrals; anal rather long; vertebrae about 40; pyloric caeca small, few. Small fishes of the coasts of Europe and northern America, sometimes ascending rivers; delicate in flesh and considerably valued as food. (After Jordan and Evermann)

143 Osmerus mordax (Mitchill)

Smelt; Ice Fish

Atherina mordax MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I. 446, 1815. New York.

Osmerus viridescens LE SUEUR, Jour. Ac. Nat. Sci. Phila. I, 230. May, 1818, Boston to Newport; DE KAY, N. Y. Fauna, Fishes, 243, pl. 39, fig. 124, 1842, streams flowing into Long Island Sound, Hackensack & Passaic rivers; STORER, Syn. Fish. N. A. 197, 1846; GÜNTHER, Cat. Fish. Brit. Mus. VI, 167, 1866.

Osmerus mordax JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 293, 1883; BEAN, Fishes Penna. 64, pl. 26, fig. 46, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 523, 1896, pl. LXXXVI, fig. 228, 1900; EVERMANN & KENDALL, Rept. U. S. Commr. Fish & Fisheries for 1894, 593, 1896, Lake Memphremagog & Lake Champlain.

The smelt has an elongate and somewhat compressed body and a long, pointed head, with the lower jaw projecting. The mouth

is large, the maxilla extending slightly behind the eye. Small teeth on the intermaxillaries and maxillaries and the front of the lower jaw. Posteriorly the teeth of the mandible are larger. The tongue is armed with a few large fanglike teeth, and there are widely set teeth on the vomer, palate, and pterygoid bones and at the root of the tongue. Gill rakers long and slender; branchiostegals eight; the dorsal small, nearly median over the ventrals; anal moderately long; scales large, thin, easily deciduous, in about 75 rows along the sides; lateral line short, not extending much beyond the end of the pectoral; a few small pyloric caeca. The hight of the body is nearly one fifth of the total length, without caudal, and nearly equal to the length of head. The eye is nearly one fifth as long as the head. The pectoral equals the longest dorsal ray in length and, also, length of anal base. The ventral is one half as long as the head. Longest anal ray not much more than one half the anal base. D. ii, 8; A. iii, 14; V. ii, 7.

The upper parts are greenish; a broad silvery band along the sides; body and fins with numerous minute dusky points.

The smelt is known along our east coast from Labrador to Virginia. It probably extends still farther north, but the record of W. A. Stearns, published in the proceedings of the National Museum for 1883, p. 124, fixes the most northern locality known at present. He found the smelt common in August in shoal water off the wharves of Cape Breton. In Pennsylvania the fish is common in the spring in the Delaware and Schuylkill rivers. In numerous lakes of Maine, New Hampshire, and other New England states, the smelt is common landlocked, and thrives as well as in the salt water.

De Kay knew the smelt as a marine species ascending the Hackensack and Passaic rivers. The species occurs also in Lakes Champlain and Memphremagog. In the former lake it reaches a large size. At Port Henry N. Y. the fish is called ice fish.

Its range has been widely extended by artificial introduction, which is very easily effected by transporting the fertilized eggs

from the small brooks in which the species spawns. The eggs are adhesive and attach themselves to stones, and their transportation is accomplished very easily.

The smelt grows to a length of 1 foot; the average size as found in the markets is about 7 inches. It enters the rivers for the purpose of spawning and is most abundant in the winter and early spring months. Spawning takes place in the Raritan river, N. J., in March. The eggs of the smelt have been artificially hatched by Mr Ricardo, Fred Mather and other fish culturists.

The smelt is an excellent food fish and is also used for bait, and still more extensively as food for landlocked salmon, lake and brook trout and other important salmonoids, which are artificially reared in lakes. It has proved to be one of the best fishes for this purpose. Immense quantities of smelts are caught during the winter months in nets, seines and by hook and line. They are usually shipped to market in the frozen condition, packed in snow or crushed ice. The fish which have not been frozen, however, are prized more highly than any others.

The smelt begins to run into Gravesend bay in December and remains during cold weather. In the spring it ascends rivers to spawn. The eggs are small ($\frac{1}{50}$ inch in diameter) and number 496,000 to the fluid quart; they adhere to stones, twigs etc. on the bottom. Some females begin to spawn when only 3 or 4 inches long.

In fish cultural operations "the spawning fish, of both sexes, are placed in troughs, which are covered to exclude light, which is very injurious to the eggs. The eggs are naturally laid and fertilized, and become attached to each other and to the troughs. They are scooped up with a flat shovel, placed on wire trays in water, and are forced through the meshes of the trays to separate them. They are hatched in automatic shad jars, blanketed to exclude light. If during hatching the eggs bunch, they are removed from the jars and again passed through the meshes of the wire trays."

The fry are hardy in transportation.

In captivity the adults live till about the end of June, when the water becomes too warm and they die. Their food consists mainly of shrimps and other small crustaceans.

Order INOMI

Lantern Fishes

Family SYNODONTIDAE

Lizard Fishes

Genus SYNODUS (Gronow) Bloch & Schneider

First superior pharyngeal cartilaginous, second without teeth, third and fourth separate, with teeth; lower pharyngeals separate; body elongate, subterete; head depressed, the snout triangular, rather pointed; interorbital region transversely concave; mouth very wide; premaxillaries not protractile, very long and strong, more than half length of head, maxillaries closely connected with them, very small or obsolete, premaxillaries with one or two series of large, compressed, knife shaped teeth, the inner and larger depressible, palatine teeth similar, smaller, in a single broad band; lower jaw with a band of rather large teeth, the inner and larger teeth depressible, a patch of strong, depressible teeth on the tongue in front, and a long row along the hyoid bone; jaws nearly equal in front; eye rather large, anterior, supraorbital forming a projection above the eye; pseudobranchiae well developed; gill rakers very small, spinelike; gill membranes slightly connected; top of head naked; cheeks and opercles scaled like the body; body covered with rather small, adherent, cycloid scales; lateral line present; no luminous spots; dorsal fin short, rather anterior; pectorals moderate, inserted high; ventrals anterior, not far behind pectorals, large, the inner rays longer than the outer; anal short; caudal narrow, forked; vent posterior, much nearer base of caudal than base of ventrals; branchiostegals 12 to 16; stomach with a long, blind sac and many pyloric caeca; skeleton rather firm.

144 Synodus foetens (Linnaeus)

Lizard Fish

Salmo foetens LINNAEUS, Syst. Nat. ed. XII. I. 513, 1766, South Carolina.
Esox salmoneus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 442, 1815, New York.
Saurus mexicanus CUVIER, Règne Anim. ed. II, 314, 1829, Mexico.
Saurus foetens GUNTHER, Cat. Fish. Brit. Mus. V, 396, 1864.
Synodus foetens JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 280, 1883; BEAN, Bull. U. S. F. C. VII, 148, 1888, 19th Rep. Comm. Fish. N. Y. 275, 1890; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 538, 1896, pl. LXXXVIII, fig. 236, 1900.

Body slender, elongate fusiform, its greatest depth about one seventh of total length without caudal; caudal peduncle short, stout, its least depth equal to length of snout; head conical, sharply pointed, its length contained four and one third times in total without caudal; snout much flattened above, pointed, its length about one fourth the length of head, and nearly twice diameter of eye; jaws nearly equal in front or the lower included, maxilla reaching well behind orbit, the upper jaw as long as postorbital part of head; anterior nostril with a flap, posterior simple, the anterior nearer to eye than to tip of snout; eye small, partly on top of head, two elevenths of length of head, about two thirds of interorbital width; teeth of upper jaw closing down over the mandible; dorsal origin nearer to tip of snout than to base of caudal, over the 18th scale of the lateral line, dorsal base one half as long as the head, longest dorsal ray equal to upper jaw, last dorsal ray one third as long as head; adipose dorsal very small and slender, its length not equal to eye; ventral equidistant from tip of snout and vent, the fin four fifths as long as the head; pectoral short and rounded, its length equal to snout and eye combined; anal origin distant from caudal base a space equal to one fourth the length without caudal, anal base three fifths as long as the head, longest anal ray one half as long as head without the snout, last anal ray one half as long as anal base; caudal deeply forked, the middle rays less than one half as long as the outer; interorbital space slightly concave. D. 10, the first two and the last simple; A. 14; V. 8; P. 14. Scales 7–59–7; here described from specimens numbered 35936, U. S. National Museum, from Fire island, L. I.

Color of upper parts olive brown or grayish, sides below lateral line paler, belly yellowish, pectorals, ventrals and anal with a yellow tint, caudal dusky, dorsal with traces of narrow bars, inside of mouth and of gill openings yellow.

The lizard fish reaches a length of 12 inches; it is found from Cape Cod to Brazil, being very common from Virginia southward. It comes into shallow waters during the summer and remains on the New York coast till October. It is a voracious species, of no value as food.

Adults and young of this species are rather common in the Great Egg bay region, N. J.

At Beesleys Point, Sep. 2, 1887, a small individual was found to have swallowed a Pleuronectes americanus, which distended the stomach of its captor laterally to nearly twice its normal width.

Abundant in thoroughfares near Somers Point August 30. One individual taken is $7\frac{3}{4}$ inches long. Some very large ones have been seen; an example caught at Beesleys Point, September 9, is nearly 9 inches long, and we have secured some larger than this.

The species is unknown to the fishermen.

The lizard fish, called sand pike by some authors, is the trout pike of Mitchill. Besides bearing these names, it is known as snakefish, cigar fish and spearfish. The species appears not to have been known to De Kay. It is very common in Great South bay, 36 specimens having been taken in the latter part of September and the first two days of October. Mitchill's examples from the head of New York bay were from 8 to 9 inches long. in Great Egg Harbor bay, though it is a very common fish, the fishermen have no name for it.

Order HAPLOMI

Pikelike Fishes

Family UMBRIDAE

Mud Minnows

Genus UMBRA (Kramer) Müller

Body oblong, covered with cycloid scales of moderate size, without radiating striae; no lateral line; head shortish, little

depressed; eye rather small; cleft of mouth moderate; ventral fins 6-rayed, below or slightly in front of dorsal; anal fin much shorter than dorsal; pectorals rather narrow, rounded, placed low, with 12 to 15 rays, which are much articulated; caudal rounded; preopercle and preorbital with mucous pores; branchiostegals six; gill rakers short, thick. Size small. Three species, very similar to each other, inhabiting the waters of the United States and Austria.

145 Umbra limi (Kirtland)

Mud Minnow; Dogfish

Hydrargira limi Kirtland, Bost. Jour. Nat. Hist. III, 277, pl. II, fig. 4, 1841.

Hydrargira fusca Thompson, Nat. Hist. Vermont, 137, 1842, Lake Champlain.

Hydrargira atricauda De Kay, N. Y. Fauna, Fishes, 220, 1842.

Hydrargyra fusca Storer, Syn. Fish. N. A. 182, 1846.

Umbra limi Günther, Cat. Fish. Brit. Mus. VI, 232, 1866; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 350, 1883; Bean, Fishes Penna. 88, 1893; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 623, 1896.

The mud minnow has a comparatively short and stout body, its depth not equal to the length of the head and about one fourth of total without caudal. The length of the head equals two sevenths of the total. The head is flattened above and rather large. D. 14; A. 9; V. 6. Scales in lateral line 35, in transverse series 15.

The color is dark olive or greenish, and the sides have irregular, narrow, pale bars, which are sometimes obscure or absent. A black bar at the base of the tail.

The mud minnow, mud dace or dogfish is found in the Great lakes region from Lake Champlain to Minnesota, being most abundant in Wisconsin. It is occasionally taken in the Ohio valley. It was not found by Dr Meek at Ithaca; but was taken in small numbers near Cayuga and Montezuma. The fish was taken by U. S. Fish Commission collectors in Griffon creek, Chaumont N. Y. July 7, and in Mill creek, Sacketts Harbor N. Y. July 2. De Kay had specimens from Lake Champlain.

It grows to a length of 4 inches. It has no value whatever except as food for other species. Like the related mud minnow

next mentioned, it is hardy and interesting in the aquarium. The name mud minnow relates to a singular habit of the fish of burrowing into the mud when the water evaporates out of a pond. It has been related that this fish has been plowed up in ponds and swamps which have become dried out. Prof. Baird has recorded the following fact about this species. "A locality which with the water perfectly clear, will appear destitute of fish will perhaps yield a number of mudfish on stirring up the mud on the bottom and drawing a seine through it. Ditches on the plains of Wisconsin or mere bog holes affording lodgment to nothing beyond tadpoles may thus be found full of melanuras."

The mud minnow shipped from Caledonia N. Y. by James Annin jr in wet moss has survived a 12 hours' journey; but it has never proved hardy either in balanced tanks or in running water. This is remarkable, because there is evidence to prove that the species can endure alternate freezing and thawing without permanent injury.

146 **Umbra pygmaea** (De Kay)

Striped Mud Minnow

Leuciscus pygmaeus De Kay, N. Y. Fauna, Fishes, 214, pl. 42, fig. 134, 1842, Tappan, Rockland Co., N. Y.; Storer, Syn. Fish. N. A. 162, 1846.
Fundulus fuscus Ayres, Bost. Jour. Nat. Hist. IV, 296, pl. XIII, fig. 2, 1844, Brookhaven, Long Island.
Melanura annulata Agassiz, Amer. Jour. Sci. Arts, 135, 1854.
Umbra pygmaea Jordan, Bull. U. S. Nat. Mus. X, 53, 1877; Bean, Fishes Penna. 88, 1893; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 624, 1896, pl. XCIX, fig. 268, 1900; Mearns, Bull. Amer. Mus. Nat. Hist. X, 317, 1898.
Umbra limi pygmaea Blatchley, Proc. Ac. Nat. Sci. Phila. 13, 1885.
Melanura pygmaea Bean, Bull. U. S. F. C. VII, 147, 1888.

The body of the mud minnow is oblong, robust; its greatest depth is contained slightly more than four times in the total length without the caudal and not equal to length of head. The snout is short; eye moderate about equal to snout, four and one half in head. Cardiform teeth on premaxillaries, lower jaw, vomer and palatine bones. The gill openings are very wide, the rakers short and rather numerous; jaws short, gape of mouth

rather wide. The body is covered with rather large cycloid scales, and the head is almost entirely scaled. D. 14; A. 8. Scales eight or nine in a transverse series, 35 from head to tail.

Color dark green, more or less mottled (in spirits brownish); sides with a dozen pale longitudinal streaks, regularly arranged; a darker stripe through eye; black bar at base of tail, which is present in very young examples as well as in the adult.

The eastern mud minnow is found from New York to South Carolina in Atlantic streams. According to Prof. Cope it is very common near Philadelphia. De Kay had very small individuals from brooks near Tappan, Rockland co. N. Y. Dr Theodore Gill collected specimens in the same county in 1855.

The species grows to a length of about 5 inches, and is well adapted for aquarium life, but has no other value except as food for larger fishes. Its habits are similar to those of the species last described.

The body is stouter than in *Umbra limi*; the head is broader, less flattened on top, with a larger eye, shorter snout and the profile more convex.

The dogfish is a most peculiar fish, as voracious as a pike and as tough-lived as a catfish. It requires but little water and can often be dug from the moist mud of ditches the water of which has evaporated. None may be found in a stream, but the puddles and muskrat holes alongside may be full of them. It is a good deal of an air breather, rising to the surface to gulp in air and then descending again, in the fashion of the paradise fish. In the aquarium it is very hardy and apt to annoy other species by driving them around and attacking their fins. When exposed to the air in freezing weather, it succumbs almost instantly, also when put into water containing much lime; on the other hand, hot weather does not in the least trouble it, except that it gets its supply of air more frequently.

In movement it is very erratic, now dashing about as if mad, again standing perfectly motionless in the water, only moving the pectorals and ventrals "like a dog, running," again only moving pectorals and the rear part of the dorsal or the latter

fin alone. It can turn its head sideways at an angle and remain awhile in that position.

When feeding, it gorges the morsel at one attempt, after staring at it a while. Sometimes when overfed, the dogfish can not swim about at all, but lies like a log on the bottom. (After Eugene Smith[1])

Family LUCIIDAE

Pikes

Genus LUCIUS Rafinesque

Body elongate, not elevated, more or less compressed posteriorly, broad anteriorly; head long, the snout prolonged and depressed; mouth very large, its cleft forming about half the length of the head; lower jaw the longer; upper jaw not protractile, most of its margin formed by the maxillaries, which are quite long and provided with a supplemental bone, premaxillaries, vomer and palatines with broad bands of strong cardiform teeth which are more or less movable; lower jaw with strong teeth of different sizes; tongue with a band of small teeth; head naked above; cheeks and opercles more or less scaly; gill openings very wide; gill membranes separate, free from the isthmus; gill rakers tuberclelike, toothed; branchiostegals 12 to 20; scales small; lateral line weak, obsolete in young specimens, developed in the adult; dorsal posterior, opposite and similar to anal; caudal fin emarginate; pectoral fins small, inserted low; ventrals rather posterior; vent normal; no adipose fin; no barbels; stomach not caecal, without pyloric appendages; pseudobranchiae glandular, hidden; air bladder simple. Basis cranii double (Cope). Fishes of moderate or large size, inhabiting the fresh waters of the northern parts of Europe, Asia and North America.

The genus Lucius is readily subdivided into three groups distinguished by their size, scaling and coloration. In the first group are three species of true pickerels, in which the cheeks and opercles are entirely scaly, the color is greenish, usually with dark reticulations, and the largest species reaches a

[1] Linn. soc. N. Y. Proc. 1897, no. 9, p. 27-28.

length of about 2 feet. To this group the subgeneric name Kenoza is sometimes applied; it includes the banded pickerel, the little pickerel and the chain pickerel, all of which occur in New York.

147 Lucius americanus (Gmelin)

Banded Pickerel

Esox lucius γ *americanus* GMELIN, Syst. Nat. 1390, 1788, Long Island, New York.

Esox niger LE SUEUR, Jour. Ac. Nat. Sci. Phila. I, 415, 1818, Lake Saratoga, New York; STORER, Syn. Fish. N. A. 185, 1846; GUNTHER, Cat. Fish. Brit. Mus. VI, 229, 1866.

Esox scomberius MITCHILL, Amer. Month. Mag. II, 322, March, 1818, Murderer's Creek, New York.

Esox fasciatus DE KAY, N. Y. Fauna, Fishes, 224, pl. 54, fig. 110, 1842, streams and ponds of Long Island.

Esox ravenelii HOLBROOK, Ichth. S. C. 201, 1860, Charleston, S. C.

Esox americanus JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 352, 1883; BEAN, Fishes Penna. 89, pl. 28, fig. 53, 1893.

Lucius americanus JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 626, 1896.

The banded pickerel has an elongate body; its depth contained about five times in the total length without caudal; the length of the head three and one fourth times in the standard length. The snout is contained two and two thirds times in the length of the head, and the eye five and one half times in the same length. The maxillary extends to vertical through middle of eye; the lower jaw projects considerably beyond the upper. Teeth in the jaws strong, directed backwards. The ventral is placed in middle of body, the dorsal and anal fins far back, opposite each other; their longest rays of about the same length, much longer than the bases of the fins. Caudal deeply emarginate. B. 11–13; D. 11–14; A. 11–12. Scales in lateral line 105. The body is usually dark green, sometimes brownish black, above; the sides greenish yellow with about 20 dark curved bars, which are generally very distinct; dorsal and caudal fins dark brown, the other fins lighter, sometimes reddish; a dark bar from the eye to angle of jaw, another from the snout through the eye to upper edge of opercle.

The banded pickerel is probably identical with the "mackerel pike" of Mitchill. It is a small fish, seldom exceeding 12

inches in length, and will not average more than ½ pound in weight. It occurs only east of the Alleghanies, from Massachusetts to Florida in coastwise streams. In Pennsylvania it is limited to waters in the eastern part of the state, and the same is true in New York.

This pickerel is too small to have much importance as a food fish. It resembles in general appearance and habits the little pickerel of the west. It frequents clear, cold and rapid brooks and is said to associate with the brook trout without injury to the latter.

Dec. 30, 1895, James Annin jr sent from Rockland N. Y. a small pickerel which had attracted his attention on account of its colors and markings. It was taken in a small spring brook, tributary to the Beaver kill, which, about 10 or 15 miles below, unites with the Delaware. Subsequently two examples were forwarded alive from the same place, and one of them is still living in the aquarium 1897. The following notes and measurements, in inches, relate to the first individual of undetermined sex, the organs being undeveloped.

MEASUREMENTS

	Inches
Length, including caudal fin	7¾
External caudal lobe (horizontally)	1⅛
Middle caudal rays (from end of scales)	½
Length of head	1¾
Greatest depth of body	1⅛
Least depth of caudal peduncle	½
Length of snout	⅝
Length of maxilla	11/16
Length of mandible	1 2/16
Diameter of eye	5/16
Distance from snout to dorsal	5 2/16
Length of dorsal base	⅞
Length of longest dorsal ray	¾
From end of dorsal to caudal origin	⅞
Distance from snout to pectoral	1⅝
Length of pectoral	13/16
Distance from snout to ventral	3⅝
Length of ventral	¾
Distance from snout to anal	5¼
Length of anal base	¾
Length of longest anal ray	11/16
From end of anal base to origin of lower caudal lobe	¾

B. 12; D. 12; A. 11; V. 9. Scales, 24-110. The maxilla reaches to below the middle of the pupil. The mandible projects $\frac{1}{16}$ of an inch when the mouth is closed. The diameter of the eye is contained five and two thirds times in length of head. The stomach was empty, but insect remains were voided from the vent.

Colors. About 20 oblique, interrupted, dark bands on the body; a narrow oblique dark band under the eye and four rather large dark blotches on the cheek and opercle; pectorals, ventrals and anal orange; a tinge of orange on the dorsal and caudal; general color olivaceous gray, with golden reflections; lower parts creamy white; iris lemon mingled with pale brown; peritoneum silvery.

All the pickerels are liable to fungus attacks without apparent cause, but, as a rule, they can be cured by the salt water treatment. Their food consists of small live killifish, which they approach slowly and deliberately till within 5 or 6 inches, when they rush, seize, and stop as abruptly as if stopped by an obstruction.

Eugene Smith says this pickerel is often found in brackish water in the vicinity of New York, and is then more brown in color. L. reticulatus is found also on Long Island close to salt water, as at Water Mill.

148 Lucius vermiculatus (Le Sueur)

Little Pickerel

Esox vermiculatus Le Sueur in Cuvier & Valenciennes, Hist. Nat. Poiss. XVIII, 333, 1846, Wabash River, Indiana.

Esox crassus Agassiz, Am. Jour. Sci. Arts, 308, 1854, Tennessee River, Huntsville, Alabama.

Esox umbrosus Kirtland, Proc. Cleveland Ac. Sci. 79, 1854, Rockport, near Cleveland, Ohio; Cope, Trans. Am. Phil. Soc. Phila. 409, 1866.

Esox cypho Cope, Proc. Ac. Nat. Sci. Phila. 78, 1865, Waterford, Michigan; Günther, Cat. Fish. Brit. Mus. VI, 230, 1866.

Esox porosus Cope, Trans. Am. Phil. Soc. Phila. 408, 1866, substitute for cypho.

Esox salmoneus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 352, 1883.

Esox vermiculatus Bean, Fishes Penna. 90, pl. 28, fig. 54, 1893.

Lucius vermiculatus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 627, 1896.

The little pickerel has a short, stout body and a long head. The greatest depth is nearly one fifth of the length without caudal and two thirds of length of head; length of head two sevenths of total without caudal; eye two fifths of length of snout, one sixth of length of head. The maxilla reaches to below middle of eye. Cheeks and opercles fully scaled; dorsal origin twice as far from eye as from end of scales, its base two fifths of head, its longest ray nearly one half of head; anal under dorsal and with slightly longer rays; ventral nearly midway between tip of snout and end of scales, its length equal to snout and to pectoral. B. 11–13; D. 12; A. 11 or 12. Scales in lateral line 105.

Body green or grayish, usually with many irregular streaks or reticulations, which are sometimes entirely lacking; sides of the head generally variegated; a dark bar extends downward from the eye, and another forward. Fins plain, but the caudal is sometimes mottled at its base.

This pickerel inhabits the valleys of the Ohio and Mississippi rivers and streams flowing into the Great lakes from the southward. In ponds formed in the spring by the overflow of river banks it is one of the characteristic fishes and is often destroyed in great numbers by the drying up of such bodies of water. In Pennsylvania the little pickerel, or trout pickerel, is common in the Ohio and its tributaries. Prof. Cope mentions it also as an inhabitant of the Susquehanna river, in which it is probably not a native.

The U. S. Fish Commission obtained a moderate number of specimens in the Lake Ontario region at the following New York localities.

Black creek, tributary of Oswego river, Scriba Corner	July 15
Lakeview hotel, 7 m. west of Oswego	July 17
Wart creek	July 24
Great Sodus bay	Aug. 16
Outlet Long pond, 4 m. west of Charlotte	Aug. 7
Marsh creek, near Point Breeze	Aug. 21

This fish grows to the length of 1 foot and is, therefore, too small to have much importance for food.

149 Lucius reticulatus (Le Sueur)

Chain Pickerel; Green Pike

Esox reticulatus Le Sueur, Jour. Ac. Nat. Sci. Phila. I, 414, 1818, Connecticut River, Adams, Mass.; Philadelphia, Pa.; De Kay, N. Y. Fauna, Fishes, 223, pl. 34, fig. 107, 1842; Kirtland, Bost. Jour. Nat. Hist. IV, 233, pl. X, fig. 2, 1844; Günther, Cat. Fish. Brit. Mus. VI, 229, 1866; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 353, 1883, Bean, Fishes Penna. 90, pl. 29, fig. 55, 1893.

Esox tridecemlineatus Mitchill, Mirror, 361, 1825, Oneida Lake, N. Y.

Esox phaleratus (Say) Le Sueur, Jour. Ac. Nat. Sci. Phila. I, 416, 1818, St Augustine, Fla.

Esox affinis Holbrook, Ichth. S. C. 198, 1860, Charleston, S. C.

Lucius reticulatus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 627, 1896; Evermann & Kendall, Rept. U. S. Commr. Fish & Fisheries for 1894, 597, 1896; Mearns, Bull. Amer. Mus. Nat. Hist. X, 317, 1898; Proc. U. S. Nat. Mus. XXI, 344, 1898.

The chain pickerel has a long and slender body, its depth near the middle equaling about two thirds of the length of the head and contained five to six times in the total without caudal. The caudal peduncle is slender, its depth little more than one third of greatest depth of body. The snout is long and pointed, as long as the postorbital part of the head and about three times the length of the eye, which is one seventh to one eighth of length of head. The dorsal base equals two fifths of length of head, its longest ray equal to snout. The anal begins under the third or fourth ray of the dorsal, its longest ray nearly one half as long as the head. Caudal deeply forked. Ventral half way from tip of snout to end of scales, its length equal to snout and slightly greater than length of pectoral. B. 15; D. 15; A. 14. Scales in lateral line about 125. The cheeks and opercles are completely scaled.

The color is usually greenish, sometimes brown or almost black. On the sides are many narrow, dark lines connected by cross streaks, forming a network which suggested the name r e t i c u l a t u s . Occasionally the body is uniform greenish, as in a specimen taken in the Potomac river a few years ago. In the young the reticulations are very obscure, and a pale stripe

is found along the middle line on the second half of the body. In adults the sides are often golden or olive yellow, and have dark reticulations. A distinct dark band under the eye.

The chain pickerel is known under other names; it is the jack of the south, the federation pike of Oneida lake, N. Y. the green pike of the Great lakes and the eastern pickerel of many writers. It does not occur west of the Alleghanies, but is found from Maine to Florida and Alabama east of this range of mountains. It lives in ponds, lakes and streams and occurs within the same territory as L. americanus, but farther away from the coast. (After Eugene Smith.[1])

At Water Mill this pickerel occurs in or near brackish water at the east end of Mecox bay, and it is in very plump condition, on account of the abundance of small fishes on which it feeds, for example, the silversides, young sunfish, and small killifishes of several kinds.

Dr Meek notes that the species seems to be subject to individual variation. In many respects the specimens from Cayuga lake appear to be intermediate between reticulatus and vermiculatus. It is not very common.

The pickerel is common in ponds and streams of the Hudson Highlands, according to Dr Mearns, and is taken in winter as well as in summer. A specimen weighing 3½ pounds was caught in Poplopen's pond in 1882. It is abundant also in Cauterskill lake, of the Catskill mountains. The U. S. Fish Commission obtained it in Black river, Huntingtonville N. Y. July 5. Examples were sent from Canandaigua lake, and young were obtained in Bronx river.

This pickerel is the largest of its group, reaching a length of 2 feet and a weight, occasionally, of 8 pounds, though this is much above the average.

Like the pike, this is one of the tyrants among fishes, a fierce and hungry marauder; and yet it has been introduced by fishermen into many waters in which it is not native and has greatly multiplied. In the Potomac, the Connecticut, the Delaware and

[1]Linn. Soc. N. Y. Proc. 1897. no. 9, p. 29.

other large rivers the pickerel abounds; it is to be found in large numbers lying in wait among the river grasses or in ponds under the shelter of leafy water plants for the minnows which it consumes in enormous numbers, or some unlucky insect, frog or snake which attracts its voracious appetite.

Spawning takes place in winter and early in the spring, and the young soon become solitary and wolfish like their elders.

The fish obtained from Canandaigua lake spawned in their tank in June 1897, and the young were naturally hatched, but they died when about ¾ inch long for want of acceptable food.

As a food fish not much can be said in praise of the chain pickerel, though it is eaten and doubtless liked by a good many people. The flesh is often coarse and watery and is always full of small bones. This fish, however, furnishes considerable sport to the angler, since it is a very free biter and fights with great boldness and stubbornness when hooked. It is caught by trolling with a spoon or still fishing with live shiners, pickerel frogs and many other baits. A minnow gang is often very effective in pickerel fishing. The hooks must be tied on gimp as a protection for the line from the sharp teeth of the fish.

This species is always hard to keep in good condition in captivity, because of its liability to fungus attacks. The salt water treatment, however, keeps the fungus in check.

Subgenus LUCIUS

The longest known and most widely distributed species of Lucius is the common pike, the typical species of the genus. In the subdivision into groups this would be the sole representative of the Lucius group, which has the cheeks fully scaled and the lower half of opercles naked. The sides are pale spotted on a darker ground, and the size is very much larger than that of the pickerels. Fossil remains of the pike have been found in quaternary deposits in Europe.

150 Lucius lucius (Linnaeus)

Common Pike; Pickerel

Esox lucius LINNAEUS, Syst. Nat. ed. X, I, 314, 1758, Europe; RICHARDSON, Fauna Bor.-Amer. III, 124, 1836; GÜNTHER, Cat. Fish. Brit. Mus. VI, 226, 1866; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 353, 1883; BEAN, Fishes Penna. 91, pl. 29, fig. 56, 1893.

Esox estor LE SUEUR, Jour. Ac. Nat. Sci. Phila. I. 413, 1818, Lake Erie; DE KAY, N. Y. Fauna, Fishes, 222, 1842; STORER, Syn. Fish. N. A. 184, 1846.

Esox boreus AGASSIZ, Lake Superior, 317, 1850, Lake Superior.

Lucius lucius JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 628, 1896, pl. C, fig. 269, 1900; EVERMANN & KENDALL, Rept. U. S. Commr. Fish & Fisheries for 1894, 597, 1896.

The pike has a stout, elongate body and a long head, with broad and produced snout. The greatest depth is about one fifth of the length without caudal. The caudal peduncle is nearly equal to one half depth of body. The eye is nearly median and about one sixth of length of head, which is $\frac{1}{4}$ of total without caudal. The mouth is very large and strongly toothed. The tongue, roof of mouth, pharynx and gill arches bristle with teeth in cardlike bands, giving the fish extraordinary power in seizing and holding its prey. The dorsal and anal fins are near the caudal. The dorsal base is a little longer than its longest ray and equals depth of body at its origin. Ventral fin midway between tip of snout and end of tail fin. B. 14 to 16; D. 17 to 20; A. 16 or 17. Scales in lateral line 120 to 125.

The ground color of the body is grayish varying to bluish or greenish gray. The sides are thickly covered with pale blotches, none of them as large as the eye, arranged nearly in rows. The dorsal, anal and caudal fins have many rounded, dark spots. Adults without dark bar below eye. Naked part of opercle bounded by a whitish streak. In the young the sides are covered with oblique yellowish bars, which afterward break up into the pale spots of the adult.

Pike is the best known name for this species, though the misnomer "pickerel" is rather extensively used. The origin of pike is involved in uncertainty; some trace it to the resemblance in shape of the snout to the pike or spear, while others believe it to refer to the darting motion of the fish when speeding through the water. The name pickerel is used in Vermont and around Lake George, N. Y. "Frank Forrester" (Herbert) styles it the great northern pickerel. The name jack is applied in Great Britain to young pike. *Brochet* is the French name, *hecht* the German and *luccio* the Italian designation of the

species. In Prof. Cope's paper in earlier reports of the Pennsylvania Fish Commission the names lake pike and grass pike are used for the fish.

Distribution. In the north temperate and arctic regions of North America, Europe and Asia the pike is equally common. In North America it extends from Pennsylvania to high northern latitudes. In Alaska, Townsend and others found it above the arctic circle, and Dall and Nelson took it in abundance in the Yukon. From Greenland and the islands of the Arctic ocean the pike appears to be absent. The identity of our American pike with the common one of Europe was recognized by Cuvier and Richardson more than half a century ago; the former compared specimens from Lake Huron with European examples, and Richardson with the English pike, and both were unable to find specific differences between the two.

The pike is said to be common in Lake Champlain and in all its larger tributaries. In the Lake Ontario region the U. S. Fish Commission collectors secured it at the following places. Mud creek, Cape Vincent N. Y. June 25, 1891, Chaumont river July 10, outlet Long pond, 4 miles west of Charlotte N. Y. Aug. 17.

Dr Meek found the species in Cayuga lake, where he says he was unable to find any other fish of the genus except the pickerel. James Annin jr obtained the pike in Silver lake, Wyoming co. N. Y. July 1, 1896. He reports that it does not occur in Canandaigua lake.

On the continent of Europe the largest recorded specimen was taken at Bregenz in 1862; this was said to weigh 145 pounds. In Scotland a pike measuring more than 7 feet and weighing 72 pounds has been reported. We do not find monsters like these in America. "Frank Forrester" mentions individuals of 16 to 17 pounds. Lake George, N. Y., is famous for its large pike. Dr Frank Presbrey of Washington D. C. caught one there in 1889 weighing a little more than 16 pounds, and more than 30 examples, averaging in excess of 10 pounds each, were taken that season by another person from Washington in the same waters.

Some of the largest pike were upward of 4 feet long. The average length is about 2 feet.

The fishing season generally begins June 1 and ends December 1; but many of the states have no close season. In Pennsylvania the close time lasts from December 1 to June 1.

The pike is a voracious fish and destroys everything within its reach in the form of animal life; other fish, water birds and mammals are consumed in enormous numbers. From its concealment, like a beast of prey it darts out suddenly on its victims and seldom misses its mark. The pike is even more destructive than the pickerel, and two of the latter, measuring 5 inches in length, have been reported to eat more than 100 minnows in a day. Spawning takes place in winter and early spring on shallows and frequently on overflowed meadows. The eggs are about $\frac{1}{8}$ inch in diameter, and a female weighing 32 pounds was estimated by Buckland to contain 595,000. The young pike has a very large yolk sac. The period of hatching varies, with the temperature of the water, from 14 to 30 days. The female is said to be larger than the male; the fish breeds at the age of three years. At the age of one year the fish may reach a length of 12 inches, and, if well supplied with food, it will increase in weight from 2 to 3 pounds yearly.

The pike is a fairly good food fish and forms an important element of the Lake Erie fisheries. As a game fish the species is widely known; it can be readily caught by trolling or spinning or on lines set under the ice. Live minnows and frogs are favorite baits; and Dr Henshall says it will rise to a large, gaudy fly. In Lake George the white chub is one of the best known baits.

Subgenus MASCALONGUS

The largest member of the pike family is the single representative of the section Mascalongus, in which the lower half of the cheeks, as well as of the opercles, is scaleless. The scales are smaller than in the other groups.

The sides and vertical fins are profusely covered with roundish black spots on a pale ground. The branchiostegals number 17

to 19. A color variety is occasionally met with having the body uniformly dark gray, unspotted.

151 Lucius masquinongy (Mitchill)

Mascalonge; Spotted Mascalonge

Esox masquinongy Mitchill, Mirror, 297, 1824, Lake Erie.

Esox masquinongy (Mitchill) Kirtland, Fishes of Ohio, 194, 1838, Lake Erie.

Esox nobilior Thompson, Proc. Bost. Soc. Nat. Hist. III, 163, 1850, Lake Champlain; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 353, 1883; Bean, Fishes Penna. 93, pl. 29, fig. 57, 1893.

Lucius masquinongy Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 629, 1896, pl. C, fig. 270, 1900; Evermann & Kendall, Rept. U. S. Commr. Fish & Fisheries for 1894, 598, 1896.

The mascalonge has a stout and moderately elongate body, its greatest depth, midway between the pectoral and ventral fins, one fifth to one sixth of the total length to the end of the scales. The caudal peduncle is short and slender, its depth one third of greatest depth. The length of the head is two sevenths of the total without the caudal, and the small eye equals less than one fourth the length of snout. The eye is nearly in the middle of the length of the head. The mouth is very large; the maxilla extends to below the hind margin of the eye. The teeth are as in the pike, but even more formidable. Dorsal and anal far back, the origin of the former a little in advance of the anal origin; the length of dorsal base about two fifths of head, longest dorsal ray one third of head, caudal deeply forked; ventral midway between end of head and end of anal, its length equal to one half the depth of body; pectoral nearly equal to postorbital part of head. B. 17–19; D. 17; A. 16; V. 12. Scales in lateral line 150.

The color is usually dark gray, sometimes immaculate as in the color variety immaculatus, but generally with numerous distinct, roundish, black spots about as large as buckshot. The dark spots are present only on the basal parts of the dorsal, anal and caudal fins. The lower parts are pale, the belly white.

The name of this giant pike is apparently derived from the language of the Ojibwa or the Cree Indians; it is variously spelled

and its meaning is uncertain, though the roots, according to H. W. Henshaw, are probably *mask* (ugly) and *kinongé* (fish). In the books it appears as muscalonge, muskellunge, muskallunge, mascalonge and maskinonge, all variations of the same term. Some writers style it the great pike, and by others it is confused with the common pike, E. l u c i u s. Prof. Cope mentions also the name blue pike.

The mascalonge is recorded by Prof Cope from Conneaut lake, Crawford co. Pa., the specimen measuring 17 inches in circumference behind the eyes. It is found occasionally in the Ohio valley. The species, however, is most abundant in the Great lakes region. In Lake Erie favorite localities are Dunkirk and Barcelona N. Y., Erie Pa. and Mills' Grove O. The northern limit of the fish is not definitely fixed.

It is asserted by some persons that the fish inhabits Cayuga lake, but others deny this. Dr Meek was unable to find it there after diligent search. It was known in Lake Champlain more than a half century ago and was described by Rev. Zadock Thompson. Mitchill and Kirtland had it from Lake Erie. De Kay confounded the mascalonge with the pike, and apparently had no example of the former. In the St Lawrence river the species is well known.

It is recorded that in 1865 Mr Schultz caught a mascalonge at Milwaukee weighing 100 pounds. In 1864 Fred Alvord declared that he had an 85 pound specimen in Maumee bay. The average length of the species is about 3 feet, and there is reason to believe that a length of 8 feet is sometimes reached. Individuals weighing 50 pounds are moderately common. With the exception of the lake trout and some of the salmon, this is undoubtedly the largest game fish in the United States.

The fish seem not to be gregarious, but occur usually in pairs. Their food consists mainly of smaller fishes, and their voracity is notorious. In the spawning season in small rivers falling into Lake Simcoe, Richardson states that they feed on small fishes and on gelatinous green balls which grow on the sides of banks under the water.

This is an excellent food fish, but not common enough to have much commercial importance. As a game fish it has few superiors. The spoon bait is very effective in the capture of mascalonge, and live fishes are extensively used. A correspondent of *Land and Water* describes a singular and successful lure made from a young brown calf's tail, through the center of which the shank of the hook was passed and fastened to a swivel.

152 Lucius masquinongy immaculatus (Garrard)

Unspotted Mascalonge; Barred Mascalonge

Esox immaculatus GARRARD MS; noticed in several fishing journals, Eagle Lake, Northern Wisconsin, *fide* JORDAN & EVERMANN.

Esox masquinongy immaculatus JORDAN, Man. Vert. ed. 5, 89, 1888.

Lucius masquinongy immaculatus JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 630, 1896.

Lucius lucius immaculatus BEAN, by error, Bull. Am. Mus. Nat. Hist. IX, 353, 1897.

Body moderately stout and elongate, its greatest depth one sixth of the total length without caudal; least depth of caudal peduncle contained two and two sevenths times in greatest depth of body, and nearly four times in length of head; head long, its length nearly three and three fourths times in total without caudal; the maxilla extending to below the front edge of the pupil, its length about one third of length of head; snout about two fifths as long as the head; eye about one eleventh as long as the head; the gill rakers mere clumps of spiny tubercles. The dorsal fin is distant from tip of snout a space equal to two and three fourths times length of head; the longest dorsal ray is three sevenths as long as the head, and only a little longer than the dorsal base. The ventral is nearly as long as the snout. The anal base is one third as long as the head; the longest anal ray is as long as the snout, and equal to the pectoral. B. 18–19; D. 16–18 (developed rays); A. 15–16 (developed rays). Scales about 153; gill rakers 13+28. Color olive green with golden tints; about 20 entire, blotchlike, irregular dark cross bands and several parts of bands and blotches intervening; lower third of pectoral pink; dorsal, caudal and anal with dark blotches forming pseudo-bands; iris lemon yellow on a silvery white ground; no black spots.

Examples of unspotted mascalonge were received at the New York aquarium from Chautauqua lake, N. Y. which belongs to the Ohio river drainage system. It appears that the typical spotted form also inhabits the Ohio basin, but occurs rarely. Mr Annin sent one individual Dec. 4, 1895, and two on May 4, 1896; from these three were obtained the following notes and measurements in inches.

MEASUREMENTS

	Dec. 4, 1895	May 4, 1896	May 4, 1896
Length, including caudal fin	23½	27⅛	25⅞
Length to end of scales	.....	23⅞	23
Length of caudal lobe (horizontally)	3⅝	.....	.....
Length of middle caudal rays	1½	.....	.....
Depth of body	3⅝	4	3⅞
Least depth of caudal peduncle	1½	1¾	1⅝
Length of head	5¾	6⅝	6⅛
Length of snout	2⅜	2¾	2½
Length of maxilla	2½	2⅜	2⅛
Length of mandible	3¾	4¼	3⅜
Diameter of eye	½	⅝	⅝
Distance from snout to dorsal	.....	18⅛	16¾
Length of dorsal base	.....	2⅜	2⅞
Length of longest dorsal ray	.....	2⅞	2⅝
Distance from snout to ventral	.....	13½	12¾
Length of ventral	.....	2½	2⅜
Length of anal base	.....	2¼	2⅛
Length of longest anal ray	.....	2¾	2⅛
Length of pectoral	.....	2¾	2⅜
Branchiostegals	19	18	19
Dorsal rays (developed)	18	16	17
Anal rays (developed)	16	15	15
Rows of scales	ca. 153	.....	.....
Gill rakers	13+28	.....	.....

In all the specimens the maxilla extends to below the front edge of the pupil. The gill rakers are mere clumps of spiny tubercles. In the two males the diameter of the eye is contained from four and one third to five times in the length of the snout, and from 10 to 11 times in the length of the head.

In the individual of Dec. 4, 1895, the lateral line tubes are distributed over various parts of the sides without much regularity except in the median line. There are no black spots. About 20 entire, blotchlike, irregular cross bands and several parts of bands and blotches intervening. The lower third of

the pectoral is pink. The dorsal, caudal and anal with dark blotches making pseudo bands. Iris lemon yellow overlying silvery white. The general color is olive green with golden tints.

The two males of May 4, 1896, furnished the following color notes.

Olive green tinged with golden bronze; sides with about 23 irregular dusky blotches resembling interrupted bands; dorsal, caudal and anal with numerous large dusky blotches, those on dorsal and anal almost forming bands; iris lemon yellow and silvery in the larger, almost vermilion and orange in smaller; a dark blotch at upper edge of opercle.

The Chautauqua lake mascalonge, according to James Annin jr who sent the specimens, is a very fine food and game fish, and attains to the weight of 50 pounds. In the spring of 1895 it was not unusual to capture individuals weighing from 40 to 50 pounds, and 20 to 30 pounds was a very common weight. In winter the fish frequent nearly the same localities as in summer, being found in the vicinity of water plants. When the lake becomes very clear in February, they go into deep water, but they live in deep water more or less all the year.

For the fish culture operations the nets are set as soon after the first of April as the ice leaves the lake. The fish begin to spawn a few days after and continue till the latter part of April. They go into shallower water for spawning; most of them spawn in from 10 to 15 feet of water. They do not resort to the gravel, like many other fish, but to mud, generally going into bays. The eggs are placed in boxes, all of which are provided with screens at top and bottom. The bottom has an extra screen, to prevent minnows from injuring the eggs. The boxes are sunk from 1 foot to 2 feet under the surface of the water. Every day or two they are drawn up, the covers removed, and all bad eggs and sediment cleaned out.

During the first experiments in Chautauqua lake, N.Y. Monroe Green and Jonathan Mason obtained the eggs in April and May 1890, and these were artificially hatched. A large female yielded 60,000 eggs. With the water at the temperature of 40°

to 46° very few of the eggs were developed, but when it neared 60°, in May, better results were secured. May 27, 75,000 young fish were planted in the lake. The eggs were hatched in a box suspended about 4 feet from the bottom in 18 feet of water.

Family POECILIIDAE

Killifishes

Genus FUNDULUS Lacépède

Body rather elongate, little elevated, compressed behind; mouth moderate, the lower jaw projecting, jaws each with two or more series of pointed teeth, usually forming a narrow band, bones of the mandible firmly united; scales moderate; gill opening not restricted above, the opercle with its margin not adnate to shoulder girdle; preopercle, preorbital, and mandible with mucous pores; dorsal and anal fins similar, small, or rather large, the dorsal inserted either in front of, above, or behind, the front of anal; ventrals well developed; air bladder present; sexes differing in color, size, and development of the fins, the anal fin in the male normal; intestinal canal short; first superior pharyngeal without teeth, second with teeth, third and fourth coossified, with teeth. Species very numerous, mostly American, inhabiting fresh waters and arms of the sea. They are the largest in size of the cyprinodonts, and some of them are very brightly colored. They are oviparous and feed chiefly on animals. Some of them are bottom fishes, burying themselves in the mud of estuaries; others swim freely in river channels and bays; still others are "top minnows," surface swimmers, feeding on floating insects in swamps and streams.

153 Fundulus majalis (Walbaum)

Bass Killy

Cobitis majalis WALBAUM, Artedi, Gen. Pisc. III, 12, 1792, Long Island.
Esox flavulus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 439, pl. IV, fig. 8, 1815, New York.
Esox zonatus MITCHILL, op. cit. 440, 1815, New York.
Fundulus fasciatus DE KAY, N. Y. Fauna, Fishes, 216, pl. 31, fig. 98, 1842.
Hydrargyra majalis CUVIER & VALENCIENNES, Hist. Nat. Poiss. XVIII, 207, 1846.

Fundulus majalis GUNTHER, Cat. Fish. Brit. Mus. VI, 322, 1866; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 331, 1883; BEAN, 19th Rep. Comm. Fish. N. Y. 274, pl. XXII, figs. 28 & 29, 1890; Fishes Penna. 84, pl. 27, fig. 51, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 639, 1896, pl. CI, figs. 271, 271*a*, 271*b*, 1900; BEAN, 52d Ann. Rept. N. Y. State Mus. 98, 1900.

The body is stout, oblong, not very deep or greatly compressed. The head is contained nearly two and one half times in the total length without caudal, and the depth four times. The snout is moderately long, one and one half times as long as the eye; the eye one fifth as long as head. The scales are moderately large, those on the head about equal to the average of those on the body; scales on the cheeks in about three longitudinal rows; about 12 rows between dorsal origin and nape. The pectoral in both sexes equals the distance from the middle of the eye to the end of the head. The ventral and anal are longer in the male than in the female. In the male the ventral is one half as long as the head, in the female only about two fifths of the head. The longest anal ray of the male equals four fifths of the length of the head, while in the female it is scarcely more than one half as long as the head. The dorsal of the male is differently shaped from that of the female, its last rays being nearly as long as the longest, while in the female the last ray is not much more than one half the length of longest ray. D. 13–14; A. 11. Scales 35–15.

The sexes may be at once distinguished by their difference in color, the female having several narrow lateral stripes, while the male has distinct cross bands varying from 12 to 20 in number. In the male the sides and upper parts are dark olivaceous; the sides are silvery, lower parts a beautiful yellowish green; the sides are also marked by a varying number of dark bands, the width of which varies also. A large black spot on the operculum. The dorsal is olivaceous with a black blotch, sometimes circular in form, on the last three or four rays. The pectorals are yellowish; ventrals yellowish green; anal olivaceous; caudal orange. In the female the lower parts are white, upper parts olivaceous, and along the sides is a median dark

band, and below this are two short, interrupted dark bars. Two or more short, transverse, dark bars on the caudal peduncle.

The striped killifish, also known as the banded or striped mummichog, bass mummy, bass fry, mayfish, yellow-tail, and New York gudgeon, is the largest member of its family known on our eastern coast. Its range extends from Cape Cod to Florida. Prof. Cope thinks that in Pennsylvania it probably ascends the Delaware as far as the boundary of the state, and I see no reason to doubt its occurrence even in fresh water.

The female is usually larger than the male, and examples measuring 8 inches in length have been recorded. It swarms in shallow bays and salt marshes, and though not used as food, it is extremely important for the subsistence of economic species and is, also, extensively used for bait. The name bass mummy, applied to the species on Long Island, refers to its use in the capture of striped bass. The species breeds in summer, and the young are abundant in shallow water among eel grass and other aquatic plants.

A permanent resident in Gravesend bay. In winter it inhabits deep, muddy holes at the mouths of creeks. In captivity it is the least hardy of all the marine killifishes.

154 Fundulus heteroclitus (Linnaeus)

Killifish; Mummichog

Cobitis heteroclita Linnaeus, Syst. Nat. ed. XII, I, 500, 1766, Charleston, S. C.

Poecilia macrolepidota Walbaum, Artedi, Gen. Pisc. III, 11, 1792, Long Island.

Esox pisciculus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 440, 1815, New York.

Esox pisculentus Mitchill, op. cit. 441, 1815, New York.

Fundulus viridescens De Kay, N. Y. Fauna, Fishes, 217, pl. 31, fig. 99, 1842, New York.

Fundulus zebra De Kay, op. cit. 218, 1842, New York.

Fundulus pisculentus Storer, Hist. Fish. Mass. 294, 1867.

Fundulus heteroclitus Günther, Cat. Fish. Brit. Mus. VI, 318, 1866; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 336, 1883; Bean, 19th Rep. Comm. Fish. N. Y. 274, pl. XXIII, fig. 30, 1890; Fishes Penna. 86, pl. 28, fig. 52, 1893; 52d Ann. Rept. N. Y. State Mus. 98, 1900.

Fundulus heteroclitus macrolepidotus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 641, 1896, pl. CII, fig. 273, male, 1900; Mearns, Bull. Am. Mus. Nat. Hist. X, 317, 1898, salt creeks along the Hudson.

The body is short and stout in both sexes; its depth one fourth of the length including the tail and slightly greater than the length of the head. The head is moderately short, with an obtuse snout and the space between the eyes very flat. The lower jaw projects slightly. The eye is about two thirds as long as the snout and one fifth the length of the head. The pectoral reaches to the ninth or tenth row of scales; its length is equal to the base of the dorsal. The dorsal is considerably nearer to the end of the tail than to the tip of the snout; its longest ray in the female one half the length of head. The anal is entirely under the dorsal; its longest ray equals the longest of the dorsal, its base about one third the length of head. The ventral origin is under about the twelfth scale of the median line, its length two thirds of that of the pectoral, considerably less than half the head; when extended it reaches nearly to vent. The least depth of the caudal peduncle is one seventh of the length including caudal. All the fins have rounded outlines, and the caudal is specially convex. Scales 14–35. D. 11; A. 11.

The females are nearly uniform olivaceous, lighter below; caudal with a median narrow band of a paler color; most of the scales having a narrow, dusky submarginal streak; the scales of the head very irregularly arranged and unequal in size. The males are dark greenish, with many narrow, irregular, silvery bars on the sides and with the belly yellowish or orange. The sides are also more or less spotted with white or yellow. The dorsal, anal and caudal are dark with many small pale spots. On the last rays of the dorsal there is frequently a dark blotch, which sometimes is surrounded by paler, giving it an ocellated appearance. In the young this blotch is often subdivided into two parts. Narrow dark bands are sometimes present in the young male.

The killifish has been found in the Delaware by Prof. Cope. It is frequently called mummichog or salt-water minnow, and the name mudfish has also been applied to it. In the vicinity of Boston it is known to boys under the name of cobbler, and on Long Island it is called mummy or chog-mummy.

This is the killifish of Schöpff, the yellow-bellied and the white-bellied killifish of Mitchill, and the big killifish and barred killifish of DeKay. The Indian name mummichog is applied to this as well as to other species, and some persons call it the salt-water minnow. In Great South bay it is the mummy or chog-mummy. It is extremely abundant in all parts of the bay, and serves as food for larger fishes.

The striking difference in the colors of the two sexes has led to their separation under distinct names by Mitchill, DeKay and other writers.

It grows to the length of 5 or 6 inches; it has no importance as a food fish, but is eaten in large numbers by many of the valuable economic fishes, particularly the striped bass and the weakfish. Dr Storer says it is an excellent bait for smelts. Piscivorous birds consume it in large quantities, and domestic ducks have been known to swallow it with apparent great relish. Eggs have been found in this species as late as August. It spawns in the spring and early summer, and the young are found in great schools in summer in the eelgrass and on sandy beaches in company with other species of killifish, the common silverside and various other fishes.

The killifish is a permanent resident in Gravesend bay, wintering in deep, muddy holes near the mouths of creeks. According to Eugene Smith, it stands captivity well and is often found landlocked in ice or quarry ponds. The flesh has a sweet taste. The range of the species is from Maine to South Carolina, usually in shallow salt or brackish water, but sometimes ascending streams beyond tidewater.

155 Fundulus diaphanus (Le Sueur)

Fresh-water Killy

Hydrargira diaphana Le Sueur, Jour. Ac. Nat. Sci. Phila. I, 130, 1817, Saratoga Lake; De Kay, N. Y. Fauna, Fishes, 219, 1842.

Hydrargira multifasciata Le Sueur, op. cit. 131, 1817, Saratoga Lake; De Kay, op. cit. 220.

Hydrargyra swampina Cuvier & Valenciennes, Hist. Nat. Poiss. XVIII, 203, 1845, New Jersey.

Fundulus multifasciatus Günther, Cat. Fish. Brit. Mus. VI, 324, 1866.

Fundulus swampina Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 332, 1883.

Fundulus diaphanus JORDAN & GILBERT, op. cit. 334, 1883; HUGH M. SMITH Bull. U. S. F. C. X, 65, 1890; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 645, 1896, pl. CIII, figs. 275, 275*a*, 1900; BEAN, Fishes Penna. 85, 1893; 52d Ann. Rept. N. Y. State Mus. 98, 1900; MEARNS, Bull. Am. Mus. Nat. Hist. X, 318, 1898.

The body is moderately slender and elongate, its greatest depth equaling about two ninths of the total length without tail, or somewhat less than the length of the head. The head is flat above, the width between the eyes equal to nearly half the length of head. The mouth is very protractile, small, its width somewhat greater than the length of the lower jaw. The upper jaw is as long as the eye, a little more than one fourth the length of head, which equals about one fourth of total length without caudal. The length of the dorsal base equals the depth of the body and much exceeds length of anal base. Length of longest dorsal ray less than one half of head; longest anal ray two thirds of length of head. The dorsal is midway between the tip of the snout and the root of the caudal. The anal is wholly under the dorsal. Length of pectoral six and one half times in total. Caudal large, convex behind. D. 14; A. 12 Scales 44–46–13.

The females are olivaceous with silvery; sides traversed by 15 to 25 narrow, dark cross bands; fins pale. The males, at least in the breeding season, are pale olive with about 20 pearly white cross bands.

The barred killifish, also known as the spring mummichog and toothed minnow, inhabits the Great lakes and their tributaries, east to Massachusetts, south to Virginia and Indiana, west to Colorado, according to Cope south to Texas. The species was first made known from Saratoga lake. It is very abundant in the Lake Ontario region, having been taken by U. S. Fish Commission collectors at the following New York localities.

Mud creek, Cape Vincent	June 25
Grenadier island, Lake Ontario	June 28
Horse island, Sacketts Harbor	June 30
Mill Creek, Sacketts Harbor	July 2

Stony Island	July 2 and 3
Little Stony brook, Henderson bay	July 4
Guffon creek, Chaumont	July 7
Chaumont river	July 10
Great Sodus bay	Aug. 6
Creek near Pultneyville	Aug. 7
Long pond, Charlotte	Aug. 17
St Lawrence river, 3 miles below Ogdensburg	July 17

According to Dr Meek, it is common on the flats and in the southern end of Cayuga lake, also in streams on the uplands, at Cayuga and Montezuma. Dr Mearns took it in Echo lake and Long pond of the Hudson Highlands. The state museum secured numerous individuals from Shinnecock bay July 21, Scallop pond, Peconic bay July 28, and Mecox bay Aug. 1, 1898.

The fish is very common in a lake at 110th street and 5th avenue, Central park, New York city.

In Eugene Smith's experience the species throve better in the aquarium than any other killifish except Fundulus heteroclitus, and became very tame in captivity, though always attacking the fins of other fishes. In the New York aquarium the fish proved to be very delicate, usually dying from fungus attacks before the salt water treatment removed the parasite.

In Ohio, and west, is found a variety with very distinct and somewhat irregular bands and the back always spotted, which has been called variety menona by Jordan and Copeland. Eastern specimens have the back unspotted and the cross bands faint and regular, but extremely variable in number. The difference in coloration of the sexes is very striking, specially in the breeding season, when the adult males have silvery cross bands.

The barred killifish grows to the length of 4 inches. It runs down into brackish waters along the east coast and ascends far up the streams, delighting in cold water. It is eaten in large numbers by the striped bass and the weakfish. In the fresh waters the black bass and trout also feed on it.

Genus LUCANIA Girard

The body oblong, compressed; lower jaw prominent, the cleft of the mouth short and very oblique; mouth moderate, the snout not produced, each jaw with a single series of conical teeth; scales very large; gill openings not restricted; dorsal and anal rays in moderate number, the dorsal above or slightly in advance of the anal; anal fin not modified in the males. Very small, oviparous fishes of the brackish waters, swamps and shallow bays of the United States.

156 Lucania parva (Baird & Girard)

Rainwater Fish

Cyprinodon parvus BAIRD & GIRARD, Ninth Smithsonian Rept. 345, 1855, Greenport, Long Island; GÜNTHER, Cat. Fish. Brit. Mus. VI, 307, 1866.

Lucania parva JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 893, 1883; BEAN, Bull. U. S. F. C. VII, 148, pl. II, fig. 18, 1888; 19th Rep. Comm. Fish. N. Y. 275, 1890; HUGH M. SMITH, Bull. U. S. F. C. X, 68, 1890; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 665, 1896, pl. CIX, fig. 292, 1900; BEAN, 52d Ann. Rept. N. Y. State Mus. 99, 1900.

Body rather short and stout in the adult, its greatest depth two sevenths of the length to base of caudal; caudal peduncle moderately long and deep, its least depth nearly one half the length of head; the mouth small, oblique, with heavy projecting lower jaw; snout short, nearly equal to eye, about two ninths as long as the head; eye rather large, its horizontal diameter two sevenths as long as the head; head stout, with obtuse muzzle, its length nearly one third of the total to base of caudal; dorsal origin midway between tip of snout and base of middle caudal rays, the dorsal base about one fifth of total length to caudal base, the longest dorsal ray one half as long as the head, the last dorsal ray a little more than one third as long as the head. The anal fin begins under the middle of the dorsal, its base as long as the snout and eye combined, its longest ray one half as long as the head. The ventral is slightly in advance of the dorsal, its length three eighths of length of head. The pectoral reaches slightly beyond the origin of dorsal, its length nearly one fifth of total length to base of caudal. Caudal large,

roundish, scarcely truncate behind in the adult. D. ii, 8; A. ii, 6; V. i, 5. Scales 10–27.

Color in life: males olive or pale brown, with bluish reflections, edges of the scales darker, dorsal dusky orange, sometimes with a large, black spot at the base in front, ocellated with orange, caudal orange yellow, tipped with black, ventrals and anal orange red, tipped with dusky, pectorals translucent; females with the fins pale olive, without black spot or edgings. Length 1½ to 2 inches.

The species is found along the coast in brackish waters from Massachusetts to Florida; very common on Long Island. Abundant in Peconic, Shinnecock, and Great South bays, and in a fresh-water stream at Water Mill L. I.; not yet reported from Gravesend bay. It seldom exceeds 1½ inches in length and is interesting chiefly on account of its translucent body and graceful movements. It has not proved hardy in captivity.

The species was first described by Prof. Baird from Greenport L. I.

Genus CYPRINODON Lacépède

Body very short and stout, the back elevated; mouth small, the bones of the jaws well formed; snout short; teeth moderate, incisorlike, tricuspid, in a single series; scales very large; dorsal fin moderate, inserted in advance of front of anal, its first ray not enlarged; anal smaller; ventral fins small, occasionally wanting in specimens from desert pools; intestinal canal little longer than body; gill membranes considerably united, free from the isthmus; gill openings restricted, the opercle above adnate to the shoulder girdle. Chubby little fishes, inhabiting the brackish waters of middle America, sometimes living in warm salt springs, their colors generally brilliant. Oviparous; the sexes similar except in color.

157 Cyprinodon variegatus Lacépède

Sheepshead Minnow

Cyprinodon variegatus LACÉPÈDE, Hist. Nat. Poiss. V, 486, 1803, South Carolina; GÜNTHER, Cat. Fish. Brit. Mus. VI, 305, 1866; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 329, 1883; BEAN, Bull. U. S. F. C. VII, 148, 1888; 19th Rept. Commrs. Fish. N. Y. 275, 1890; 52d Ann. Rept. N. Y. State Mus. 99, 1900; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 671, 1896, pl. CXI, fig. 296, 296*a*, 1900.

Esox ovinus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 441, pl. IV, fig. 7, 1815, New York.

Lebias ovinus De Kay, N. Y. Fauna, Fishes, 215, pl. 27, fig. 84, 1842.

Lebias ellipsoides Le Sueur, Jour. Ac. Nat. Sci. Phila. II, 6, pl. 2, figs. 1, 2, 1821; Storer, Syn. Fish. N. A. 179, 1846.

Body short and stout, heavy anteriorly, its width more than one half its hight, its greatest hight two fifths to nearly one half of total length to base of caudal, the males higher than the females; caudal peduncle short, its least depth equal to postorbital part of head; head conical, its width at gill covers equal to its length without the snout, its length one third of total without caudal; jaws very short, mouth small, terminal, slightly oblique when closed, the lower jaw somewhat prominent, the upper protractile; the maxilla curved abruptly downward at the end, about as long as the eye, not reaching to the front margin of the orbit; eye circular, longer than snout, not quite one fourth as long as the head, placed near the top of the skull, about two thirds of width of interorbital space; dorsal origin a little nearer to tip of snout than to base of middle caudal rays, the dorsal base, in males, as long as the head without the snout, three and two thirds in total length without caudal, the longest dorsal ray, in males, about equal to length of head, and twice as long as the last ray. The ventral reaches nearly or quite to anal origin, its length one half length of head. The anal base is two fifths as long as the head, its longest ray one fifth of total without caudal. The pectoral is narrow and as long as the head in males, reaching almost to the beginning of the anal; in females it is not quite so long as the head, and does not reach beyond the middle of the ventral. Caudal fin short and truncate, its length about one fourth of the total without caudal, and about equal to the head without the snout. D. 11; A. 10; B. 6. Scales 17–28.

This is known in Great South bay as the porgy mummy. Mitchill recorded it as more rare than the other killifishes. DeKay has it as the Sheepshead Lebias.

This little fish seldom exceeds 2 inches in length. The males are more brightly colored and higher bodied than the females, and have a narrow, dark margin to the caudal fin.

The Sheepshead killifish ranges from Cape Cod to Florida. It is not important except as food for other fishes. Very common in salt water ditches.

One of the best of its family for aquarium purposes, as it thrives and breeds in captivity; the young, however, may be eaten by their parents.

Order SYNENTOGNATHI

Family ESOCIDAE

Needlefishes

Genus TYLOSURUS Cocco

Body elongate, very slender, not much compressed; both jaws prolonged into a beak, the lower jaw somewhat the longer, much the longer in young fishes, the very young resembling Hemiramphus; each jaw armed with a band of small, sharp teeth, beside which is a series of longer, wide set, sharp, conical, unequal teeth; no teeth on vomer or palatines; scales small, thin; lateral line running along the side of the belly, becoming median on the tail; no finlets; dorsal fin more or less elevated anteriorly; caudal fin short, unequally lunated or forked; pectorals moderate; ventrals small, the latter inserted behind the middle of the body; gill rakers obsolete; bones usually more or less green; size comparatively large. Species numerous. Voracious fishes, chiefly American; one species crossing to Europe; some of them entering rivers. This genus differs from the old world genus Esox (Linnaeus) Rafinesque (=Belone, Cuvier) in the absence of gill rakers and of vomerine teeth.

158 **Tylosurus marinus** (Walbaum)

Billfish; Silver Gar

Esox marinus WALBAUM, Artedi. Gen. Pisc. III, 88, 1792, based on SCHÖPF, Sea Snipe, Long Island.

Esox longirostris MITCHILL, Amer. Month. Mag. II, 322, March, 1818.

Belone truncata LE SUEUR, Jour. Ac. Nat. Sci. Phila. II, 126, 1821; DE KAY, N. Y. Fauna, Fishes, 227, pl. 35, fig. 112, 1842; GÜNTHER, Cat. Fish. Brit. Mus. VI, 244, 1866; STORER, Hist. Fish. Mass. 136, pl. XXIV, fig. 3, 1867.

Tylosurus longirostris JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 374, 1883.

Tylosurus marinus JORDAN & FORDICE, Proc. U. S. Nat. Mus. 351 1886; BEAN, Bull. U. S. F. C. VII, 146 1888; 19th Rept. Commrs Fish. N. Y. 273, 1890; Fishes Penna. 97, 1892; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 714, 1896; MEARNS, Bull. Amer. Mus. Nat. Hist. X, 318, 1898; BEAN, 52d Ann. Rept. N. Y. State Mus. 99, 1900.

Body long, slender and somewhat compressed. The depth of the body is less than one fifth of length of head; the eye is rather large, two fifths of the length of the postorbital part of the head. The pectoral is as long as the postorbital part of the head and twice as long as the ventral. The distance of the dorsal from the root of the caudal is one fourth its distance from the tip of the lower jaw. The anal ends under the end of the dorsal and begins in advance of the dorsal origin. The ventral is almost equidistant from the root of the caudal and the hind margin of the eye. D. 15 to 16; A. 15 to 17; V. 6.

The body is green with a broad silvery band along the sides and a dark bar on the operculum. The scales and bones are green.

The silver gar, also called soft gar, billfish and needlefish, is found along our coast from Maine to Texas, and, though a marine species, it ascends rivers far above the limits of tides. It has been found in the Susquehanna river at Bainbridge Pa., and it also runs up the Delaware, the Hudson and other rivers.

Schöpff is authority for the names sea pike and sea snipe for this species at New York. Mitchill refers to it as the long-jawed fresh-water pike, and also as the billfish, a name still in use in various localities for this fish. Billed eel is the name used in Great South bay. DeKay calls it the banded garfish. Still another name used for the species is needlefish; and it is said that gar is derived from a Saxon word meaning needle.

The species is found on our coast from Maine to the Gulf of Mexico. Mearns has found it in the Hudson and its estuaries in autumn. Mitchill observed it so frequently in that river that he considered it an inhabitant of fresh water. In Gravesend bay the fish occurs from June to September. In Shinnecock bay, Mecox bay, and Great South bay the writer collected it almost everywhere.

This species reaches a length of 4 feet. It is very destructive to small fishes, which are readily seized in its long and strongly toothed jaws. In the Gulf of Mexico the habits of the silver gar have been observed by Silas Stearns, whose notes are to be found in the *Fishery Industries of the United States*. It is found at Pensacola Fla. in the summer, but retreats farther south in the winter.

The silver gar swims at the surface and feeds on schools of small fish. On the New York coast it devours killifishes, anchovies, silversides, and other little species. Its movements are swift and its aim certain. It has been known to seize mullet and other fish one third as large as itself and is sometimes killed by attempting to swallow spiny fish too large to pass through its throat. It spawns in the bays in May and June. Mr Stearns found it to be an excellent food fish, though it is seldom eaten on the Florida coast.

Though the fish is one of excellent flavor and, according to DeKay, greatly relished by epicures, it meets with little favor in northern markets. Nothing is recorded about its breeding habits except the statement of Silas Stearns that it spawns in the bays of the Gulf coast in May and June. The fish is not hardy in transportation and in captivity.

159 Tylosurus raphidoma (Ranzani)

Houndfish; Guardfish

Belone raphidoma Ranzani, Nov. Comm. Ac. Nat. Sci. Inst. Bonon, V, 359, pl. 37, fig. 1, 1842, Brazil; Gunther, Cat. Fish. Brit. Mus. VI, 249, 1866.

Belone gerania Cuvier & Valenciennes, Hist. Nat. Poiss. XVIII. 437, 1846, Martinique; Günther, op. cit. 241, 1866.

Belone crassa Poey, Memorias, II, 291, 1861, Cuba.

Belone melanochira Poey, op. cit. 294, 1861; Günther, op. cit. 249, 1866.

Tylosurus gladius Bean, Proc. U. S. Nat. Mus. 239, 430, 1882, Pensacola: Bull. U. S. F. C. VII, 146, pl. II, fig. 15, 1888, young, Ocean City, N. J.

Tylosurus crassus Jordan, Proc. U. S. Nat. Mus. 112, 1884.

Tylosurus raphidoma Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 715, 1896, pl. CXVI, fig. 308, 1900.

Body robust, little compressed, its greatest width a little more than two thirds its greatest depth, which is about one fourth

the length of head and one thirteenth of total to base of caudal; caudal peduncle slightly depressed, a little broader than deep, with a slight dermal keel; head broad, broader above than below, three tenths of total length to base of caudal; interorbital space nearly two thirds of length of postorbital part of head, with a broad, shallow, naked, median groove, which is wider behind and forks at the nape; supraorbital bones with radiating striae; distance between nostrils a little more than one sixth of length of snout; jaws comparatively short, strong, tapering, very stiff, lower jaw wider and longer than upper, both jaws with broad bands of small teeth on the sides, within these a series of very large knife-shaped teeth. The length of the longest teeth is a little more than three times their breadth. Posterior teeth in both jaws directed backward, anterior teeth erect, number of large teeth about 25 on each side of the upper jaw and 23 below, length of the large teeth about one fifth of diameter of eye, no vomerine teeth. Upper jaw from eye about one and three fourth times as long as the rest of the head; eye large, one seventh as long as snout, three eighths of postorbital part of head, and five ninths of interorbital width; maxillary entirely covered by preorbital; cheeks densely scaled; opercles scaly only along anterior margin; scales minute, specially on the back, somewhat larger below. Dorsal fin rather high in front, becoming low posteriorly, the hight of its anterior lobe equaling postorbital part of head, its longest ray two fifths of length of dorsal base. In a young example, 6½ inches long, the posterior part of the dorsal is much elevated, the longest ray equaling the distance from middle of pupil to end of head. Caudal fin lunate, its lower lobe nearly one half longer than the upper; middle rays about as long as eye; anal fin falcate, low posteriorly, its anterior lobe equal to anterior dorsal lobe; ventral fins inserted midway between base of caudal and middle of eye, a little shorter than pectorals, and equal to postorbital part of head; upper ray of pectorals broad, sharp edged, length of pectoral three and two fifths in head, and slightly greater than postorbital part of head. D. i, 21–23; A. i, 20–23; V. 6; P. 14.

Color dark green above, silvery below; dorsal and pectoral blackish; ventrals somewhat dusky; anal yellowish, the lobe slightly soiled; caudal dusky olivaceous; no suborbital bar and no scapular spot; a slight dusky shade on upper posterior part of cheeks, and a yellowish bar on anterior edge of opercle; caudal keel black.

This species is very closely allied to T. f o d i a t o r Jordan & Gilbert, described from Mazatlan, differing from it apparently in its longer jaws, slightly greater number of fin rays, and larger scales. Here described from the type of T. g l a d i u s Bean, which is 29 inches long.

A young example was seined at Ocean City N. J. Aug. 1, 1887. D. i, 21; A. i, 20. Length 6½ inches.

A dark cutaneous flap attached along the side of the mandible and folded underneath, meeting its fellow of the opposite side and concealing a small part of the lower jaw; dorsal black, except on the first six rays, which are pale, much elevated at the posterior part, where the longest ray equals the distance from the middle of the eye to the end of the head. 14 black blotches on sides not extending to caudal, the largest two thirds as wide as length of eye; paired fins and anal pale; caudal the same, except anterior half of upper lobe, on which the membrane covering the rays is black, while the intervals between the rays are pale; back greenish; under surface, except mandibular flap, silvery.

This species has not previously been recorded in the region.

The usual range of the species is from the West Indies and Florida Keys to Brazil; the young straying northward occasionally in summer. The fish reaches a length of 5 feet and is sometimes dangerous to fishermen in its powerful leaps from the water. The scales and bones are green; the flesh is little esteemed for food on this account. A description and figure of the young are published by Bean in the Bulletin of the U. S. Fish Commission for 1887, p. 146, pl. 2, fig. 15.

160 Tylosurus acus (Lacépède)

Houndfish

Sphyraena acus Lacepède, Hist. Nat. Poiss. V, 6, pl. 1, fig. 3, 1803; Martinique.

Belone latimana Poey, Memorias, II, 290, 1861, Havana; Günther, Cat. Fish. Brit. Mus. VI, 249, 1866.

Belone jonesi Goode, Am. Jour. Sci. Arts, 295, 1877, Bermuda; Günther, Ann. Mag. Nat. Hist. III, 150, 1879.

Belone caribbaea Günther, Cat. Fish. Brit. Mus. VI, 241, 1866, not of Le Sueur.

Tylosurus acus Jordan & Fordice, Proc. U. S. Nat. Mus. 355, 1886; Jordan & Evermann, Bull. 16, U. S. Nat. Mus. 716, 1896, pl. CXVI, fig. 306, 1900.

Body slightly compressed, its greatest depth one twentieth of total length, its greatest width about one twenty-eighth of the same; free part of tail somewhat depressed, quadrate, its depth one third of greatest hight of body; caudal carinae moderate, black; head somewhat depressed above, striated, with a broad, shallow median groove which expands posteriorly into a wide, somewhat depressed triangular area, length of head contained three and one fourth times in total length without caudal; superciliary region sharply striated; snout equal to maxillary, one fifth of total length, and three times postorbital part of head; mandible slightly shorter than distance from snout to nape, 10 times vertical diameter of eye, and projecting beyond tip of upper jaw; eye equal to width of interorbital area and one eighth of length of head; teeth large, sharp, not very close, maxillary teeth about 60, the largest one sixth as long as the eye; mandibular teeth about 60, the largest one ninth as long as the eye; no vomerine teeth; dorsal origin at a distance from tip of snout equal to two and one fifth times length of head, slightly behind anal origin, length of dorsal base five times long diameter of eye, greatest hight of dorsal fin equal to greatest width of head, and contained seven and one half times in length of head, last dorsal ray about one third of anterior rays; anal base terminating anteriorly to end of dorsal at a distance equal to length of first dorsal ray; ventral origin midway between front of orbit and base of middle caudal rays, length of ventrals one seventh

of length of head; length of pectoral slightly greater than that of postorbital part of head; caudal forked, the lower rays about one fourth longer than the upper. D. 23–24; A. 21–22; P. 13; V. 5; B. 12. Scales in lateral line (estimated) 380.

Above deep green, below silvery white, opercles and cheeks silvery white, anterior rays of dorsal and pectoral fins blackish, caudal carinae also blackish.

"The houndfish, as it is called in Bermuda, is a graceful, active species attaining to the length of 3 feet or more. It frequents swift tide courses, where it preys upon small fishes, particularly the schools of silversides and anchovies. It takes the hook well." *Goode*

The species occurs in the West Indies and sometimes strays northward as far as Buzzards bay in summer; it was first described from Martinique. Individuals have been recorded from Beaufort N. C.

Family HEMIRHAMPHIDAE

Balaos

Genus HYPORHAMPHUS Gill

Body elongate, moderately compressed, the sides of the body not vertical, but more or less convex; the dorsal outline parallel with that of the belly; upper jaw short, lower jaw prolonged into a slender beak, bordered with membrane, this beak shorter in the young; premaxillaries forming a triangular plate, the teeth of which fit against the toothed part of the mandible; maxillaries joined to premaxillaries; teeth feeble, mostly tricuspid; gill rakers rather long; head covered above with large, shieldlike scales; scales large, deciduous; no finlets; caudal fin more or less forked, the lower lobe the longer; dorsal and anal similar, opposite each other, not modified in the males, last ray of dorsal usually short; ventrals small, inserted well forward, nearly midway between opercle and base of caudal. Oviparous. Air bladder large, simple, not cellular. Young with the lower jaw short. Sides in our species with a distinct silvery band, as in Atherina. Species numerous, in all warm seas,

going in large schools, but usually remaining near shore, feeding chiefly on green algae. Size comparatively small.

161 Hyporhamphus roberti (Cuv. & Val.)

Halfbeak

Hemirhamphus roberti Cuvier & Valenciennes, Hist. Nat. Poiss. XIX, 24, 1846, Cayenne; Günther, Cat. Fish. Brit. Mus. VI, 263, 1866; Meek & Goss, Proc. Ac. Nat. Sci. Phila. 223, 1884; Bean, Bull. U. S. F. C. VII, 147, pl. III, fig. 16, 1888; 19th Rept. Commrs. Fish. N. Y. 274, 1890.

Hemirhamphus unifasciatus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 376, 1883.

Hyporhamphus roberti Jordan & Evermann, Check-List Fish. N. A. 321, 1896; Bull. 47, U. S. Nat. Mus. 721, 1896, pl. CXVII, fig. 312, 1900; Bean, 52d Ann. Rept. N. Y. State Mus. 100, 1900.

Body compressed, elongate, its greatest depth one eighth of total length to caudal base, its greatest width equal to postorbital part of head; caudal peduncle short and deep, its least depth equal to eye. From eye to end of upper jaw equals one third the distance from end of upper jaw to hind margin of opercle. Head including lower jaw three eighths of total length without caudal, without projecting part of lower jaw two elevenths of the same; eye equal to interorbital width, about one eighth of length of head (one fourth of head to end of upper jaw); projecting part of lower jaw a little longer than rest of head; dorsal origin over the anal origin, 34 rows of scales between it and the nape, base of dorsal equal to eye and postorbital part of head combined, longest dorsal ray equal to postorbital part of head, last dorsal ray less than one half the longest, and about two thirds of the eye; anal base slightly shorter than dorsal base, longest anal ray slightly longer than postorbital part of head, last anal ray one half of eye; ventral origin about midway between eye and base of caudal, the fin about as long as the postorbital part of head; pectoral base high, on the level with the eye, the fin about as long as upper jaw and eye combined; caudal fin symmetrically forked, the middle rays two thirds as long as the external, and nearly twice as long as the eye (from end of scales only a little longer than the eye); dorsal and anal fins densely scaled; lateral line com-

mencing at the isthmus, running close to the ventral edge of the body to the origin of the ventrals, where it rises slightly and is discontinued over the end of the anal base. D. ii, 13; A. i, 15; V. i, 6; P. 10; B. 12. Scales 7–54; vertebrae 34+17=51.

Translucent green above; the scales above with dark edges; a narrow silvery band, about one half the width of eye, along the side from axil of pectoral to base of caudal; tip of lower jaw crimson in life and with a short filament; three narrow dark streaks along middle of back; anterior part of dorsal and anal and tips of caudal dusky, almost black; peritoneum black.

The halfbeak is occasionally found on our northern coast to Cape Cod, but appears to have been unknown to Mitchill and De Kay. The species ranges southward to the Gulf of Mexico. We found 12 small examples Oct. 1, 1890, at Fire island. Two young examples were taken in Great Egg Harbor bay in 1887, and a larger one, 6¼ inches long, was taken in the same locality. According to B. A. Bean this fish was not abundant in the Chesapeake, at Cape Charles, Va., during September 1890.

The halfbeak is a rare fish in New York waters. It attracts attention because of the great inequality in the length of the jaws, the lower jaw being many times as long as the short upper jaw. One of the most striking color marks of this fish is the crimson tip of the lower jaw. The body is silvery, darker on the back, and has a distinct silvery lateral stripe.

In 1898 the writer collected this species for the New York state museum in small numbers in Great South bay, during August and September. Only one adult was obtained. The localities are: south side Great South bay, Clam Pond cove, and Horsefoot creek. This fish, like the silver gar, is readily taken at night by means of a lantern. The light dazes the fish, so that it does not see the net.

Genus EULEPTORHAMPHUS Gill

This genus consists of pelagic species related to Hemirhamphus, the body much more slender and greatly compressed, and the pectorals very long, approaching those of the flying fishes. Ventrals small, inserted posteriorly. Air blad-

der not described, probably cellular. One species in our limits.

162 Euleptorhamphus velox Poey (?)

Slender Halfbeak

Euleptorhamphus velox Poey, Syn. Pisc. Cubens. 383, 1867, Cuba; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 724, 1896.
?*Hemirhamphus longirostris* Günther, Cat. Fish. Brit. Mus. VI, 276, 1866.
Euleptorhamphus longirostris Putnam, Proc. Bost. Soc. Nat. Hist. 238, 1870.
Hemirhamphus (Euleptorhamphus) longirostris Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 377, 1883.

Body much compressed, elongate, its greatest depth one eleventh of total length from tip of upper jaw to base of caudal; greatest width of head equal to long diameter of eye; least depth of caudal peduncle two thirds of eye; snout equal to eye, three and one third in head (length of head here is from tip of upper jaw to hind margin of opercle); length of head including lower jaw two fifths of total to base of caudal, the lower jaw projecting beyond upper a distance equal to three times rest of head; eye three in head, greater than interorbital width; dorsal origin at a distance from tip of snout equal to four and two thirds times length of head (without lower jaw), dorsal base equal to nearly three times hight of body, longest dorsal ray two thirds length of head; the anal begins under the third ray of the dorsal, its base two and one third times hight of body, its longest ray equal to hight of body; ventral short, slightly shorter than eye, three and two thirds in head, extending nearly half way to anal origin; pectorals long, reaching half way from pectoral origin to anal origin, nearly twice as long as the head; caudal lobes very unequal, the upper much shorter than the lower. D. 22; A. 21; V. 6; P. 7, the upper very broad and long, the others slender. The back with a very thin edge. Color light brown above, the sides from the upper edge of the pectoral base downward bright silvery, this extending also on the head.

The species is found in the West Indies; it has been taken at Newport R. I., and at Cape Cod. It reaches a length of 18 inches. The Hemirhamphus macrorhynchus of

Cuvier and Valenciennes, taken in the south Pacific, appears to be closely related.

Family SCOMBERESOCIDAE

Sauries

Genus SCOMBERESOX Lacépède

Body elongate, compressed, covered with small, thin, deciduous scales, the general aspect being that of a mackerel; both jaws in the adult more or less prolonged, forming a slender beak, the lower jaw always the longer, teeth very feeble, pointed, maxillaries joined fast to premaxillaries; pectoral and ventrals small; dorsal and anal low, similar to each other, each with four to six detached finlets, as in the Scombridae; gill rakers numerous, long and slender; pharyngeal bones essentially as in Exocoetus, fourth upper pharyngeal on each side wanting or fused with the third, third pharyngeal greatly enlarged, separate from its fellow, covered with tricuspid teeth, second with simple teeth, first toothless, lower pharyngeals united, forming a triangular bone with concave surface, covered with tricuspid teeth; into the hollow of this bone the upper pharyngeals fit.

Pelagic fishes, swimming close to the surface in large schools in temperate regions. They bear strong analogic resemblances to the mackerels in form, color and habits, as well as in the dorsal and anal finlets. The significance of these resemblances is unknown.

Young with the jaws short, precisely as in the genus Cololabis, but lengthening with age, which is not the case in Cololabis. Air bladder large.

Atlantic.

163 **Scomberesox saurus** (Walbaum)

Saury; Skipper

Esox saurus Walbaum, Artedi. Gen. Pisc. III, 93, 1792, Cornwall.
Scomberesox scutellatum Le Sueur, Jour. Ac. Nat. Sci. Phila. II, 132, 1821, Newfoundland.
Scomberesox equirostrum Le Sueur, Jour. Ac. Nat. Sci. Phila. II, 132, 1821.

Scomberesox storeri De Kay, N. Y. Fauna, Fishes, 229, pl. 34, fig. 111, 1842, New York; Storer, Hist. Fish. Mass. 137, pl. XXIV, fig. 4, 1867.
Scomberesox saurus Fleming, Brit. Anim. 184; Günther, Cat. Fish. Brit. Mus. VI, 257, 1866; Goode & Bean, Bull. Essex Inst. XI, 21, 1879; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 375, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 725, 1896, pl. CXVII, fig. 314, 1900.

Body compressed, elongate, its greatest hight one ninth of total length to base of caudal; anal equal to eye and postorbital part of head combined; least hight of caudal peduncle equal to eye; both jaws slender and produced, the lower longer than upper, the distance from eye to tip of lower jaw equaling one fifth of total to base of caudal; eye one third as long as postorbital part of head, about one fifth of length of upper jaw; small scales on opercle, but none on subopercle; body covered with small scales; dorsal origin at a distance from front of eye equal to five times hight of body, dorsal base three times as long as the eye, longest dorsal ray one half as long as postorbital part of head, last dorsal ray equal to eye, five separate finlets behind the dorsal; anal under the dorsal, its base slightly longer, as long as postorbital part of head, longest anal ray equal to longest of the dorsal, last anal ray scarcely equal to eye, six finlets behind the anal; caudal fin deeply forked, symmetric, the outer rays as long as the anal base; ventrals midway between front of eye and base of caudal, length of fin about twice diameter of eye, distance from ventral origin to anal origin equal to length of upper jaw; length of pectoral one fourth the length of head to tip of upper jaw; lateral line containing minute, roundish pores, near the ventral edge, in modified scales which extend obliquely backward. D. 11–v; A. 13–vi; V. i, 5; P. 14. Scales 14–124 (136 to free part of middle caudal rays, 80 rows from axil of pectoral to origin of dorsal); opercle with about 8 rows of scales.

Back brownish to upper level of eye; sides with a silvery band, nearly as broad as the eye and almost on the same level; lower parts silvery with a golden tinge overlying it.

The saury grows to the length of 18 inches. It inhabits the temperate parts of the Atlantic in Europe and the United

States, congregating in schools in the open seas, where it is preyed on by porpoises, tunny, bonito, cod, bluefish and other predaceous animals. At Provincetown Mass., according to Storer, large quantities are yearly thrown on the shore, but they are considered worthless, while on other parts of Cape Cod they are taken in immense numbers, and are considered very nutritious food.

The saury, or skipper, is migratory, arriving on our coast in summer and departing on the approach of cold weather. It is a surface swimmer and, therefore, is particularly liable to the attacks of voracious fishes. Couch says:

It is sometimes seen to rise to the surface in large schools and fly over a considerable space. But the most interesting spectacle, and that which best displays their great agility, is when they are followed by a large company of porpoises, or their still more active and oppressive enemies, the tunny and bonito. Multitudes then mount to the surface and crowd on each other as they press forward. When still more closely pursued, they spring to the hight of several feet, leap over each other in singular confusion, and again sink beneath. Still further urged, they mount again and rush along the surface by repeated starts for more than 100 feet, without once dipping beneath, or scarcely seeming to touch the water. At last the pursuer springs after them, usually across their course, and again they all disappear together. Amidst such multitudes—for more than 20,000 have been judged to be out of the water together—some must fall a prey to the enemy; but, so many hunting in company, it must be long before the pursuers abandon. From inspection we should scarcely judge the fish to be capable of such flights, for the fins, though numerous, are small and the pectorals far from large, though the angle of their articulation is well adapted to raise the fish by the direction of their motions to the surface. Its power of springing, therefore, must be chiefly ascribed to the tail and the finlets. It rarely takes bait; and, when this has happened, the boat has been under sail, the men fishing with a "lash," or slice of mackerel made to imitate the living body.

The skipjack is frequently seen springing above the surface on our coasts, and no doubt at such times it is pursued by bluefish, bonito and, probably, mackerel or cod.

Family EXOCOETIDAE

Flying Fishes

Genus EXOCOETUS (Artedi) Linnaeus

Body elongate, broad above, somewhat compressed; head short, blunt, narrowed below; mouth small; jaws very short, about equal; chin without barbel; maxillaries not joined to the premaxillaries; teeth very feeble or wanting; eyes large; gill rakers moderate; scales large, deciduous; no finlets; dorsal fin short, opposite anal; caudal widely forked, the lower lobe the longer; pectoral fins very long, reaching past the beginning of the anal, and serving as organs of flight, their great size enabling these fishes to sustain themselves in the air for some time; ventral fins large, posteriorly inserted, also used as organs of flight; air bladder very large; no pyloric caeca. Species numerous in all warm seas, living mostly in the open water and swimming in large schools.

Subgenus EXOCOETUS

164 Exocoetus volitans Linnaeus

Flying Fish

Exocoetus volitans LINNAEUS, Syst. Nat. ed. X, 316, 1758; JORDAN & MEEK, Proc. U. S. Nat. Mus. 57, 1885; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 734, 1896, pl. CXVIII, fig. 318, 1900.

Exocoetus rubescens RAFINESQUE, Amer. Month. Mag. II, 205, January, 1818, Banks of Newfoundland.

Exocoetus affinis GÜNTHER, Cat. Fish. Brit. Mus. VI, 288, 1866.

Exocoetus melanurus JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 379, 1883.

Exocoetus exiliens JORDAN & GILBERT, op. cit. 380 and 904, 1883.

The hight of the body is nearly one sixth of the total length without caudal, the length of the head one fourth. The depth of the head equals the distance from the tip of the snout to the hind margin of the orbit. Snout little produced, shorter than eye, which is two sevenths to one third as long as the head; interorbital space flat or slightly concave, slightly greater than diameter of eye; width of body at pectoral base four sevenths of length of head; dorsal origin opposite anal origin, length of longest dorsal ray two fifths of length of head; anal fin long, its

longest ray one third of length of head; pectoral fin reaching slightly beyond dorsal and anal, its length five sevenths of that of the body; ventral origin midway between the eye and the base of caudal, the fin reaching beyond the middle of the anal base, its length two sevenths of length of body. D. 11–13; A. 11–13. Scales 55 (30 to 35 rows between occiput and dorsal origin; 25 rows before ventrals), 6 rows between the origin of dorsal and the lateral line.

Pectoral fin with an oblique white blotch across its lower half, and with a narrow whitish edge; ventrals grayish or whitish, with a slight dusky shade in the axil; dorsal and anal without dark markings.

The flying fish is found in open seas on the Atlantic coast; it extends northward to the Grand Banks of Newfoundland; it is known also in southern Europe, and in the Pacific and the Indian ocean.

The flight of the flying fish has been much discussed, for and against; but no doubt remains in the minds of those who have seen the action at close range that the flight is genuine. Not only can the fish start from the water and rise into the air, but it can also change its direction suddenly at will, to escape its pursuers, and it has been observed to hover like a humming bird or a great moth and then dart off suddenly out of reach of the net thrust out to secure it. Such an occurrence took place at Woods Hole Mass., some years ago in the presence of the writer.

The flying fish is an excellent food fish, but does not come to our markets frequently, because of its habitat in the open sea. It comes aboard vessels occasionally in storms or when trying to escape from its enemies, and is highly prized by its captors.

The species reaches the length of 1 foot.

Subgenus CYPSELURUS Swainson

165 Exocoetus heterurus Rafinesque

Flying Fish

Exocoetus heterurus RAFINESQUE, Caratteri Ale. Nuov. Gen. 58. 1810, Palermo; JORDAN & MEEK, Proc. U. S. Nat. Mus. 59. 1885; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 735, 1896.

Exocoetus comutus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. 418, pl. V, fig. 1, 1815, New York.

Exocoetus norcboracensis MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, pl. V, fig. 3, 1815; Amer. Month. Mag. II, 323, March, 1818; DE KAY, N. Y. Fauna, Fishes, 230, pl. 36, fig. 114, 1842, near New York; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 904, 1883.

Body slender, its greatest depth contained from five to five and one third times in the total length without caudal; length of head contained four and two thirds in total to base of caudal; the snout slightly shorter than eye, its length three and three fourths times in head, while that of the eye is contained three and one fifth times; dorsal origin in advance of anal origin, dorsal base from one and one half to two times as long as anal base; first ray of pectoral simple, second divided, third and fourth rays longest, extending to last ray of dorsal and contained one and four ninth times in total length without caudal; ventral origin midway between eye and base of caudal fin, the ventrals reaching last ray of anal, the length contained two and three fourth times in length of body. The lower caudal lobe is three fifths longer than the upper, which is equal in length to the hight of the body. D. 14; A. 9; P. 15; V. 6. Scales 58–63, 33 rows before the dorsal fin, 7 rows between the dorsal origin and the lateral line; vertebrae 31+14=45.

Pectoral fins grayish brown with a broad whitish margin, an oblique white band on their lower half; dorsal and anal uniform grayish without bands; ventrals whitish, slightly dusky in the axils.

The species grows to the length of 15 inches. The young often have a long barbel at the chin, this disappearing entirely in the adult.

Dr Mitchill described a specimen, 1 foot long, which was taken in a seine near New York.

This flying fish inhabits the Atlantic ocean and is most abundant in the tropical parts, but strays northward to England and to the banks of Newfoundland.

166 **Exocoetus furcatus** (Mitchill)

Flying Fish

Exocoetus furcatus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 449, pl. V, fig. 2, 1815; De Kay, N. Y. Fauna, Fishes, 231, 1842.

Exocoetus nuttalli Le Sueur, Jour. Ac. Nat. Sci. Phila. 10, pl. IV, fig. 1, 1821, Gulf of Mexico; Günther, Cat. Fish. Brit. Mus. VI, 286, 1866.

Cypselurus furcatus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 380, 1883.

Exocoetus furcatus Günther, Cat. Fish. Brit. Mus. VI, 286, 1866; Jordan & Meek, Proc. U. S. Nat. Mus. 61, 1885; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 737, 1896.

Body slender, compressed, moderately elongate, its depth contained five and one fourth times in total length without caudal; head not very broad, much narrowed forward, its length contained four and one half times in total without caudal; the snout rather pointed, more compressed than in other species; interorbital area flat, its width at anterior margin of orbit equal to diameter of eye, which is one third of length of head; mouth small, maxillary not reaching orbit, its length four and three fourths in head, mandible two and one half in head; snout four and one fifth in head; eye one third of length of head; pectoral fin long and broad, its length one and two ninths in length of body, extending to 10th ray of dorsal, first pectoral ray simple, slightly more than one half the length of fin, second ray divided, third and fourth rays longest; ventral origin midway between hind margin of eye and base of caudal, ventrals long, four ninths of length of body, their tips reaching almost to caudal fin; dorsal fin rather high, its longest ray two thirds as long as the head, its base nearly equal to head; anal fin inserted farther back than dorsal, its base three fifths as long as dorsal base, its longest ray one half as long as the head; lower caudal lobe two sevenths as long as the body. D. 13; A. 9 to 10. Scales in lateral line 46; about 29 rows in advance of dorsal fin and about 23 on the lateral line in advance of the ventrals; 8 rows between the dorsal origin and the lateral line.

Brownish above, silvery below; the lower posterior half of pectorals black, the upper pectoral rays with a broad white band, the tips of the rays whitish, other parts marbled with

black; the ventrals black except on two outer rays, on inner ray, and a small spot on next two inner rays, about one fourth distance from ventral origin; axil of ventrals pale. Günther describes the ventral as having the posterior part black. Three black spots on dorsal fin and three blackish cross bands on the lower caudal lobe, a black spot on tips of third, fourth, fifth, and sixth rays of the anal, or the lower part of the fin sometimes black.

The species grows to the length of 6 inches. Young individuals have barbels at the symphysis of the lower jaw, which vary in length and disappear with age. The fish is found abundantly in warm seas, ranging north to Cape Cod and to the Mediterranean. Specimens have been taken at Newport R. I.

Dr Mitchill described the species from an example 3 inches long. His specimen had two barbels, each half an inch long. The eyes, according to his description and figure, are very much larger than in Exocoetus heterurus.

167 Exocoetus gibbifrons Cuv. & Val.

Exocoetus gibbifrons Cuvier & Valenciennes, Hist. Nat. Poiss. XIX, 118, 1846, Atlantic; Jordan & Meek, Proc. U. S. Nat. Mus. 65, 1885; Jordan, Proc. U. S. Nat. Mus. 528, 1886; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 741, 1896.

Body robust, little compressed, its greatest depth one sixth of the total length without caudal; head rather short, interorbital area slightly concave, about one fourth wider than eye; profile of snout convex, descending more abruptly than in any other American species, making a decided curve downward; snout rather blunt, one fourth as long as the head; length of head contained four and three fifth times in total without caudal; maxillary two ninths as long as head; pectoral fins rather broad and long, two thirds of total without caudal, their tips reaching to tips of last rays of dorsal, first ray of pectoral simple, its length five elevenths of length of fin, second pectoral ray simple, about one half longer than first ray, third pectoral ray divided, fourth ray longest; ventral origin midway between hind margin of eye and root of caudal, length of ventrals about one third of total without caudal, the fin reaching to last anal

ray; dorsal origin far in advance of anal origin, longest dorsal ray five elevenths of length of head; anal base five eighths as long as dorsal base, longest anal ray one third of length of head; least depth of caudal peduncle contained three and one fifth times in length of head, the lower caudal lobe two sevenths of total length without caudal. D. 12; A. 8. Scales before dorsal 30; before ventrals 25; between dorsal origin and lateral line 7.

Color brown above, silvery below; on each scale on the upper part of the body a darker brown spot near its posterior extremity, which gives the appearance of a dark brown streak along each row of scales; pectorals uniformly brown, or greenish brown; ventrals dusky, nearly black mesially, the posterior part of the fin still darker; no dark markings on dorsal or anal fins; caudal dusky, plain.

Atlantic ocean, two specimens known, both examined by Dr Jordan, from whose description the above was taken. One individual was secured by Samuel Powell at Newport R. I.; the other was obtained by Dussumier in the Atlantic ocean and by him presented to the Museum of Natural History at Paris. This example is 9 inches long.

Order HEMIBRANCHII

Half-gills

Family GASTEROSTEIDAE

Sticklebacks

Genus EUCALIA Jordan

Fresh-water sticklebacks, feebly armed, the skin not mailed, the dorsal spines few and nondivergent, the gill membranes forming a free fold across the isthmus, pubic bones fully united. One species known.

168 Eucalia inconstans (Kirtland)

Brook Stickleback

Gasterosteus inconstans KIRTLAND, Bost. Jour. Nat. Hist. III, 273, pl. II, fig. 1, 1841, brooks of Trumbull County, Ohio; STORER, Syn. Fish. N. A. 64, 1846; BEAN, Bull. 15, U. S. Nat. Mus. 130, 1879; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 394, 1883.

Eucalia inconstans JORDAN, Proc. Ac. Nat. Sci. Phila. 65, 1877; EIGENMANN, Proc. Ac. Nat. Sci. Phila. 238, 1886; BEAN, Fishes Penna. 98, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 744, 1896; EVERMANN & KENDALL, Rept. U. S. Commr. Fish & Fisheries for 1894, 599, 1896, Franklin County, Vermont.

The body is more elongated than in the other sticklebacks described, and stouter, the caudal peduncle has no keel, and the skin is entirely smooth. The ventral spines and pubic bones are very small, the latter concealed under the skin. The thoracic processes are covered by the skin, slender and widely separated. The dorsal spines are short, nearly equal in length, placed in a straight line, the anterior spines shortest. The ventral spines are small and serrated. The depth equals one fourth and the head two sevenths of the total length without caudal. D. III–IV, I, 10; A. I, 10. Males in the breeding season are jet black, tinged entirely with coppery red. The females and young are greenish, variegated with darker.

The brook stickleback occurs in the fresh waters from New York westward to Dakota and is said to extend north to Greenland. A variety from Cayuga lake has been described by Dr Jordan. It has the ventral spines longer than the pubic bones.

In Pennsylvania the brook stickleback inhabits the Ohio valley. In New York it occurs only in the western part, being specially abundant in the Lake Ontario region. The U. S. Fish Commission has specimens from Salt brook, 1½ miles above Nine Mile point, June 11, 1893, Mill creek, Sacket Harbor, July 2, Cape Vincent, July 2, Black river, Huntingtonville, July 5, Three Mile creek, Oswego, July 27, Four Mile creek, Nine Mile point, near Webster, August 9, and Long Pond, Charlotte, August 17. Evermann and Bean collected it also July 28, 1894, at Saranac river, Plattsburg. Dr Meek found it common in standing and sluggish water on the flats of Cayuga lake basin. John W. Titcomb obtained it from a small brook in Franklin county, Vt., the outlet of Franklin pond, a tributary of Pike river, which flows into Missisquoi bay.

It grows to a length of 2½ inches, and has no value as food, but is an interesting aquarium fish. It is however extremely

pugnacious, and, when these fish are kept in confinement, great mortality is caused by their quarrels. The species is abundant in small streams, where it secretes itself among aquatic plants and is always alert to attack small fishes and insects. Specimens have recently been obtained from an artesian well in South Dakota, the well having a depth of 700 feet. From this great depth the fish were brought up in full strength and vigor, and they were kept in an aquarium several months afterward. A similar occurrence has been recorded by Mrs Eigenmann, in the *Proceedings of the National Museum for 1883*, p. 217, of Williamson's stickleback at San Bernardino Cal. The well in this case was only 191 feet deep. There is no doubt that the fish reach the wells through streams which become subterranean in a certain part of their course.

This species is a nest-builder and is vigorous in the defense of its eggs and young.

This fresh-water stickleback appears to live better in balanced tanks than in flowing water and is not hardy in captivity. It feeds readily on chopped hard clams and G a m m a r u s, the latter being one of its natural foods.

169 Eucalia inconstans cayuga Jordan

Cayuga Lake Stickleback

Eucalia inconstans cayuga Jordan, Man. Vert. ed. 1, 249, 1876, Cayuga Lake, Ithaca, N. Y.; Meek, Ann. N. Y. Acad. Sci. IV, 312, 1888; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 744, 1896.

According to Dr Jordan, this variety has longer ventral spines than the common brook stickleback, these being as long as the pubic bones (two thirds as long in i n c o n s t a n s). The size is generally smaller, but the fin rays are the same as in i n c o n s t a n s.

The variety occurs in small brooks and in the lakes about Ithaca and Syracuse N. Y.

Genus PYGOSTEUS Brevoort

This genus is characterized by the presence of 9 to 11 divergent spines and by the weakness of its innominate bones.

As in Eucalia, the gill membranes form a broad fold across the isthmus. Vertebrae 14 18—32. Species two, in northern regions, the following cosmopolitan; a second, Pygosteus sinensis Guichenot, from China.

170 Pygosteus pungitius (Linnaeus)

10 spined Stickleback

Gasterosteus pungitius Linnaeus, Syst. Nat. ed. X, 296, 1758, Europe; Günther, Cat. Fish. Brit. Mus. I, 6, 1859; Storer, Hist. Fish. Mass. 43, pl. VIII, fig. 5, 1867; Bean, Bull. 15, U. S. Nat. Mus. 133, 134, 1879; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 393, 1883; Bean, 19th Rept. Commrs. Fish. N. Y. 244, 1890.

Gasterosteus occidentalis De Kay, N. Y. Fauna, Fishes, 68, pl. 42, fig. 135, 1842; Storer, Syn. Fish. N. A. 63, 1846.

Gasterosteus concinnus Richardson, Fauna Bor.-Amer. III, 57, 1836, Saskatchewan River and Great Bear Lake.

Gasterosteus nebulosus Agassiz, Lake Superior, 310, pl. IV, fig. 2, 1850.

Pygosteus pungitius Eigenmann, Proc. Ac. Nat. Sci. Phila. 235, 1886; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 745, 1896; Bean, 52d Ann. Rept. N. Y. State Mus. 100, 1900.

Body moderately elongate and compressed, its greatest depth one sixth of total length to base of caudal rays, its width one tenth of the same length and two fifths of the length of the head. The head is one fourth of total length to base of caudal, its width contained two and one third times in its length; the length of the snout equals the width of the interorbital space, and nearly one fourth the length of the head; the upper jaw is slightly more than one fourth the length of head, and the mandible is nearly as long as the eye, which is contained about three and one fourth times in length of head. The spinous dorsal is inserted at a distance from tip of snout equal to two sevenths of total length without caudal; its base is a little longer than the head; its first and second spines equal, and one fourth as long as the head; its last spine less than one fifth as long as the head. The base of the soft dorsal is three times as long as the mandible; the antecedent spine is as long as the mandible; the first ray is longest, and is twice as long as the upper jaw. The anal origin is twice as far from tip of snout as the spinous dorsal; the anal base is twice as long as the middle caudal

rays, and equals twice width of body; the first anal spine is about equal to one half the depth of body; the first anal ray longest and one half as long as the head. The middle caudal rays equal width of head and about three sevenths of length of head; the external rays are slightly more than one half the length of head; the length of the caudal peduncle equals three times the length of last dorsal spine; the least hight of the peduncle is contained seven and one third times in length of head. The pectoral is twice as long as the mandible; the ventral is at a distance from tip of snout equal to three times length of ventral spine; the ventral spine is usually about two fifths as long as the head, or somewhat more. The dorsal spines are all in the same line in a furrow, but they diverge so as to form a zigzag series. Pubic bone weak, lanceolate, not serrate, its length about two fifths head; ventral spines slender, pungent, serrulate above and below; gill membranes free from isthmus behind, gill rakers long and slender; caudal fin lunate, slightly emarginate. D. VII to XI, I, 9; A. I, 8. Color brownish above, the upper part of sides with numerous darker blotches simulating bands, lower parts silvery, pubic and thoracic regions often black. Length 3 inches.

The 10 spined stickleback inhabits the northern parts of Europe, the Atlantic coast of America from Long Island to the Arctic ocean; also tributaries of the Great lakes and northward into British America and Alaska. In the Arctic fresh waters it is represented by a form with shorter ventral spine, smaller eye, lower fins, and other characters.

Notwithstanding its small size, this fish serves a very useful purpose as food for the salmon and trout, and arctic explorers have utilized it in vast numbers for feeding their dogs. Occurring as it does in shallow fresh-water lagoons in summer, apparently landlocked, and freezing solidly in winter, it has always been a mystery how it survives.

This stickleback is less abundant in Gravesend bay than the two spined and three spined species. In Great South bay it is known as the thornback. In 1890 it was seen only once. In

1898 the state museum obtained a few specimens from Shinnecock bay, Peconic bay and several stations in Great South bay.

This species appears to run upstream farther than the others. In the aquarium it often attacks fish and tears their fins into shreds. During the breeding season the male becomes of a rosy hue beneath. It is a hardy fish, enduring captivity better than the other species. Often found in pools in the woods where seemingly no other fish occur. (After Eugene Smith[1])

Genus GASTEROSTEUS (Artedi) Linnaeus

Sticklebacks with the innominate bones coalescent on the median line of the belly, behind and between the ventral fins, forming a triangular or lanceolate plate. Gill membranes united to the isthmus; tail slender, and usually keeled; skin variously covered with bony plates; dorsal spines three in number, strong, with nondivergent bases. Species numerous. Fresh waters and shores of all northern regions; the species highly variable, those found in the sea usually with the body completely mailed, the fresh and brackish water forms variously mailed or even altogether naked.

171 Gasterosteus bispinosus Walbaum

Two spined Stickleback

Gasterosteus bispinosus WALBAUM, Artedi, Gen. Pisc. III, 459, 1792; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 396, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 748, 1896, pl. CXIX, fig. 320, as *aculeatus*, 1900; EUGENE SMITH, Proc. Linn. Soc. N. Y. 31, 1898; BEAN, 52d Ann. Rept. N. Y. State Mus. 100, 1900.

Gasterosteus aculeatus GOODE & BEAN, Bull. Essex Inst. XI, 5, 1879; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 395, 1883; BEAN, Fishes Penna. 98, 1893; not of Linnaeus.

Gasterosteus neoboracensis DE KAY, N. Y. Fauna, Fishes, 66, pl. 6, fig. 17, 1842.

Gasterosteus biaculeatus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 430, pl. I, fig. 10, 1815, New York; DE KAY, N. Y. Fauna, Fishes, 65, pl. 3, fig. 8, 1842, New York and Hudson River to Albany; STORER, Syn. Fish. N. A. 62, 1846; Hist. Fish. Mass. 40, pl. VIII, figs. 2, 3, 1867.

The body is fusiform, moderately elongate and compressed; the caudal peduncle is short and slender and distinctly keeled. The hight of the body is less than the length of the head and

[1] Linn. soc. N. Y. Proc. 1897. no. 9, p. 30-31.

about one fourth of the total without caudal. The eye is one fourth as long as the head. The sides are covered by about 33 bony plates. The processes from the shoulder girdle cover the breast except a small naked area between them. At the base of each dorsal spine is a large rough bony plate to which the spine is hinged in such a way that it may be fixed and immovable at the will of the fish. The pelvic bone is lanceolate. A cusp at the base of the ventral spine. The spines are all closely serrated, those in front of the anal and soft dorsal smallest. D. II, I, 11–13; A. I, 9.

The living fish is greenish olive, lighter on the sides, the lower parts silvery. The gill covers are silvery with dusky spots; the iris silvery; pupil black; fins pale; the ventral membrane sometimes red.

The two spined stickleback or burn stickle is found on both sides of the Atlantic, its range on our coast extending southward at least to New Jersey and northward to Labrador. This is the largest of the sticklebacks and is said to grow to a length of 4 inches. In the North Pacific and Bering sea there is a related species, G. cataphractus Pallas, which has been styled the salmon killer. In Pennsylvania Mr Seal has found this fish abundant in pools and ditches along the Delaware.

De Kay found this stickleback in the salt creeks about New York and in the Hudson river as far up as Albany. The state museum obtained it in 1898 in Shinnecock bay, July 22, and in Scallop pond, Peconic bay, July 28. It is not common in summer. The following notes are from an article by Eugene Smith of Hoboken.

Exceedingly common in the tidal creeks in the spring. The nest of this fish is made on and in the sand with the aid of bits of straw, weeds, etc. After the female has deposited the eggs, the male stands over the nest and fans it with the pectorals, only leaving to get food, or to resent an intrusion; he often kills the female with whom he has paired. During this time the male is red below and bluish and greenish above, with indistinct darker bars. After the spawning season is over, they seem to die off, at least they do in captivity. With proper attention the young can be raised to quite a size.

The two spined stickleback thrives and breeds in captivity, but will not endure extreme heat in summer, and the adults will eat their young.

Genus APELTES De Kay

Body moderately elongate, somewhat compressed, the back elevated at the beginning of the soft dorsal fin, thence declining in nearly a straight line to tip of snout; tail very slender, not keeled; no bony dermal plates, the skin naked; innominate bones not joined on the median line but separated, forming a bony ridge on each side of the abdomen, below which the strong ventral spines are depressible; chest mostly bony; bare area in front of pectorals small, but distinct; gill rakers rather short, gill membranes attached to the isthmus, without free edge; free dorsal spines three, strong, the first the longest, directed to one side, the next two directed toward the other side at different angles, attached spine of dorsal and anal well developed, a bony ridge on each side of the spinous dorsal.

172 Apeltes quadracus (Mitchill)

Four spined Stickleback

Gasterosteus quadracus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 430, pl. I, fig. 11, 1815, New York; DE KAY, N. Y. Fauna, Fishes, 67, pl. 6, fig. 18, 1842, the generic name Apeltes proposed; GUNTHER, Cat. Fish. Brit. Mus. I, 7, 1859; STORER, Hist. Fish. Mass. 41, pl. VIII, fig. 4, 1867.

Gasterosteus millepunctatus AYRES, Bost. Jour. Nat. Hist. IV, 294, pl. XII, fig. 3, 1844. Old Mans Harbor, Long Island.

Apeltes quadracus GOODE & BEAN, Bull. Essex Inst. XI, 5, 1879; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 396, 1883; BEAN, 19th R. pt. Commrs. Fish. N. Y. 244, 1890; Fishes Penna. 99, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 752, 1896, pl. CXX, fig. 322, 1900; EUGENE SMITH, Proc. Linn. Soc. N. Y. No. 9, p. 31, 1898; MEARNS, Bull. Am. Mus. Nat. Hist. X, 318, 1898; BEAN, 52d Ann. Rept. N. Y. State Mus. 100, 1900.

The body is fusiform in shape, the snout pointed and the caudal peduncle slender. The sides are somewhat compressed. The depth of the body equals the length of the head and is one fourth of the total without caudal. D. III–IV, I, 11; A. i, 8. The skin is scaleless. The first dorsal spine is the highest, its length about half that of head.

The living fish has the upper parts greenish brown. Below the lateral line the color is darker and is mottled by the extension upward of the white color of the abdomen. Young specimens have the brown color aggregated into several cross bands, which become indistinct in the adult. The ventral membrane is broad, scarlet in color, giving rise to one of the popular names.

In Great South Bay the four spined stickleback is called thornback. This is the "bloody stickleback" of Storer's *Fishes of Massachusetts*. It appears to be the commonest member of its family in this bay in September and early October. We found it common in various parts of the bay at a time when the two spined stickleback, Gasterosteus bispinosus, was not once seined, and only a single specimen of the 10-spined, P. pungitius, was secured. Localities at which we have collected the species are: Swan creek, Blue Point cove, Blue Point Lifesaving station, Great River beach and Fire Island. The species is most plentiful in brackish streams where there is an abundance of aquatic plants. In 1898 the state museum obtained it from the following additional localities: Shinnecock bay, Peconic bay, Mecox bay, Howell's point, Great South bay, Bellport Lifesaving station, Nichol's point and Fire Island inlet. Examples taken at Patchogue August 24 were in fresh water.

This species reaches a length of 2 inches. It swarms in the shallow waters, specially in the northern part of its habitat, and is particularly plentiful in brackish streams where there are numerous aquatic plants. In salt marshes it is one of the commonest of the little fishes, and it is not uncommon in the mouths of rivers. In Pennsylvania Prof. Cope records it as abundant in the tide water streams and ditches of the Delaware. It runs up stream into purely fresh water and is commonly associated with the killies in small ditches and pools. This stickleback builds a rudimentary nest of plant bits, and behaves like the above mentioned P. pungitius and G. bispinosus, in most respects. It is hardy and can be kept all the year

round. I have successfully raised this fish to nearly mature growth. (After Eugene Smith[1])

The remarkable spinning habits of this fish have been described by Prof. John A. Ryder in the bulletin of the U. S. Fish Commission for 1881.

Family FISTULARIIDAE

Cornet Fishes

Genus FISTULARIA Linnaeus

Body extremely elongate, much depressed, broader than deep; scaleless, but having bony plates present on various parts of the body, mostly covered by the skin; head very long, the anterior bones of the skull much produced, forming a long tube, which terminates in the narrow mouth, this tube formed by the symplectic, procthmoid, metapterygoid, mesopterygoid, quadrate, palatines, vomer, and mesethmoid; both jaws, and usually the vomer and palatines also, with minute teeth; membrane uniting the bones of the tube below, very lax, so that the tube is capable of much dilation; post temporal coossified with the cranium; branchiostegals five to seven; gills four, a slit behind the fourth; gill membranes separate, free from the isthmus, gill rakers obsolete; basibranchial elements wanting, pseudobranchiae wanting; air bladder large; spinous dorsal fin entirely absent, soft dorsal short, posterior, somewhat elevated; anal fin opposite it and similar; caudal fin forked, the middle rays produced into a long filament; pectorals small, with a broad base, preceded by a smooth area as in Gasterosteidae, pectoral ossicles 3; interclavicles greatly lengthened, supraclavicles very small; ventral fins very small, wide apart, abdominal (through partial atrophy of the girdle, by which they lose connection with the interclavicles), far in advance of the dorsal, composed of six soft rays; pyloric caeca few; intestine short; vertebrae very numerous (I 44 to 49–28 to 33), the first four vertebrae very long. Fishes of the tropical seas, related to the

[1]Linn. Soc. N. Y. Proc. 1897. no. 9, p. 31.

sticklebacks in structure, but with prolonged snout and different ventral fins. A single genus, with three species.

The bony shields, characteristic of this genus, are the following:

1 A narrow strip along the median line of the back behind the skull (confluent neural spines).

2 The pair of broader lateral dorsal shields are peculiar bones, separated processes of the occipital bone. These shields are the longest, provided anteriorly with a ridge, which is prolonged and extends far backward between the muscles of the back. This ridge is flexible, and does not interfere with the lateral movements of the fish; it appears to serve as a base for the attachment of muscular fibers.

3 The narrow shield on the side is the postclavicle, its posterior part being dilated and fixed to the lateral dorsal shields.

4 The ventral shields are the interclavicles; their posterior half is broadest, much pitted inferiorly; they are narrower before the middle, leaving a free lanceolate space between them, and are again a little widened anteriorly, where they join the clavicle and urohyal. These plates extend as far backward as the ankylosed vertebrae. (After Jordan and Evermann)

173 Fistularia tabacaria Linnaeus

Trumpet Fish

Fistularia tabacaria Linnaeus, Syst. Nat. ed. X, I, 312, 1758; De Kay, N. Y. Fauna, Fishes, 233, 1842; Storer, Syn. Fish. N. A. 191, 1846; Günther, Cat. Fish. Brit. Mus. III, 529, 1861; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 389, 1883; Bean, Bull. U. S. F. C. VII, 146, 1888; 19th Rept. Commrs. Fish. N. Y. 273, 1890; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 757, 1896.

Fistularia neoboracensis Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 437, pl. III, fig. 8, 1815.

Fistularia serrata De Kay, N. Y. Fauna, Fishes, 232, pl. 35, fig. 113, 1842, Massachusetts; Storer, Hist. Fish. Mass. 140, pl. XXV, fig. 1, 1867; Goode & Bean, Bull. Essex Inst. XI, 4, 1879, Rockport Mass., not of Cuvier, Règne Anim. ed. 1, 349, 1817.

Body greatly depressed, elongate, its depth about one thirty-fourth of its length to base of caudal and only about two thirds of its width. The middle caudal rays are produced into a thread-

like filament, which is a little longer than the snout. The snout is greatly prolonged, two and three fourths times as long as the rest of the head. Mouth at the end of the long tube oblique, the lower jaw projecting a distance equal to one third of diameter of eye; upper jaw two thirds as long as postorbital part of head, lower jaw nearly twice as long as upper; eye nearly equal in length to upper jaw, about nine and one half in length of head; snout three and two thirds in total length to caudal base; margin of orbit with thin, sharp points in front and behind; dorsal origin at a distance from tip of snout equal to three times length of snout, base of dorsal slightly longer than eye, longest dorsal ray one fourth the length of snout; anal exactly opposite dorsal, its base equally long, its longest ray also equal to longest dorsal ray; ventrals small on a narrow base, their distance from tip of snout and end of external caudal rays nearly equal; pectorals short, on a broad base, their length one half the length of head without the snout; caudal lobes equal, the upper external rays three fifths as long as the head without the snout. D. 14; A. 13; V. 7.

Reddish brown above, with numerous large, oblong, pale blue spots on the sides and back, arranged in series; under surface of head and belly at least to ventral fins, pale and silvery.

The fish was known to Dr Mitchill and described by him from a specimen 14 inches long. We are not informed where he obtained this example, but it was an individual in the fresh condition. Dr De Kay called it the spotted pipefish and takes his account from the report of Dr Mitchill.

The trumpet fish is generally common in the West Indies and neighboring seas, where it is said to reach the length of 6 feet. It is occasionally taken as far north as Cape Cod. It is not common in that region, and is apparently rare in Great South bay, though three examples were taken at Fire island, September 30, and one at Blue Point Lifesaving station, October 7. In Great Egg Harbor bay, N. J. the species is moderately abundant, as the writer seined 25 specimens in August and September 1887.

The species is interesting on account of its peculiar structure, but is without economic value.

Order LOPHOBRANCHII

Tuftgills

Suborder SYNGNATHI

Family SYNGNATHIDAE

Pipefishes

Subfamily SYNGNATHINAE

Genus SIPHOSTOMA Rafinesque

Body elongate, very slender, six or seven-angled, not compressed, tapering into a very long tail, the dorsal keels of the trunk not continuous with those of the tail; head slender, tapering into a long, tubelike, subterete snout, which bears the very short, toothless jaws at the end; humeral bones firmly united with the "breast ring;" body covered with a series of bony, keeled, radiated plates, arranged in linear series; dorsal fin distinct, rather short, inserted before or opposite the vent, which is near the middle of the body; caudal fin present, rather small; anal fin minute, close behind vent; pectorals developed, short and rather broad. Male fishes with an egg pouch along the under side of the tail, formed by two cutaneous folds, and splitting lengthwise to release the young fishes. Species very numerous, inhabiting all warm seas; abounding in bays among the seaweeds, and entering the rivers. The females in most species are deeper than the males, with more robust trunk, with longer snout, and a more distinct ventral keel.

Subgenus SIPHOSTOMA

174 Siphostoma fuscum (Storer)

Common Pipefish

Syngnathus fuscus STORER, Rept. Fish. Mass. 162, 1839, Nahant.

Syngnathus peckianus STORER, op. cit. 163, pl. I, fig. 2, 1839, Holmes' Hole, Marthas Vineyard; Syn. Fish. N. A. 238, 1846; Hist. Fish. Mass. 218, pl. XXXIII, fig. 3, 1867.

Syngnathus fasciatus DE KAY, N. Y. Fauna, Fishes, 319, pl. 54, fig. 174, 1842.

Syngnathus viridescens DE KAY, op. cit. 321, pl. 54, fig. 176, 1842, Hudson River, at Sing Sing.

Siphostoma fuscum and *peckianum*, GOODE & BEAN, Bull. Essex Inst. XI, 4, 1879.

Siphostoma fuscum JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 383, 1883; BEAN, Bull. U. S. F. C. VII, 134, 1888; 19th Rept. Commrs. Fish. N. Y. 244, 1890; 52d Ann. Rept. N. Y. State Mus. 101, 1900; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 770, 1896.

The female is much deeper bodied than the male, the depth of body equaling one third of length of head, while in males it is only one fourth of this length. Tail very long, slender, and tapering, its length three fifths of total length without caudal; snout a little longer than rest of head, with a well marked median keel above and below, the upper one serrulate; occiput, nuchal plates and opercle keeled, the carinations on opercle sometimes nearly obsolete; belly slightly convex and with a low keel; eye small, five in snout, three in postorbital part of head; dorsal fin at a distance from tip of snout equal to two and two thirds times length of head, the base of the fin one fifth longer than head, the longest ray two sevenths as long as base of fin, and about one third as long as the head, the fin covering 5.5 body rings (4.5.5.4); anal fin of female reduced to two or three rays on a very narrow base, its length about equal to length of eye; caudal convex when expanded, the middle rays longest, as long as the postorbital part of head; pectoral short, on a broad base, its length one fourth the length of head. D. 36 to 40; rings 19+37 (or 18 to 20+36 to 40.)

Color brown above, pale below, everywhere mottled with brown; under surface of snout pale, lower part of opercles silvery.

The common pipefish is abundant on our Atlantic coast from Cape Ann to Virginia. It is known as the billed eel in Great South bay. It is abundant in all parts of the bay. Though this species is not valuable for food or bait, it is an interesting aquarium fish and has the same singular breeding habits as the sea horse. After the ova of the females are excluded, they are received and hatched, and the young are cared for, in the marsupium of the male. The species, according to De Kay, ascends the Hudson to Sing Sing, where it breeds in slightly brackish water. It is to be found in shallow water among aquatic plants. The female is conspicuously different from the male in its colors and the much greater depth of its body. The pipefish is moderately abundant in summer in eelgrass and sea lettuce in Gravesend bay. In 1898 the state museum had it from all parts of Great South bay and from Shinnecock,

Peconic, and Mecox bays. Both young and adults were abundant during the summer.

Males, females and young were abundant at Ocean City N. J. early in August 1887; but the males were more numerous than the females. The egg pouches of the males were filled with eyed embryos, arranged in four series on each side. A male 6½ inches long, taken near Ocean City, August 31, had the pouch unsymmetrically filled, the left side containing more than two thirds of the whole number of embryos and increasing in carrying capacity from behind forward. This is the billfish at Somers Point.

In the aquarium the species is fond of shrimp eggs and small Gammarus; but, on account of the difficulty of securing proper food, its life in captivity is usually short. In a slowly circulating tank, at a temperature of 54° F. several individuals were alive and, apparently, in good condition.

Subfamily HIPPOCAMPINAE

Genus HIPPOCAMPUS Rafinesque

The body strongly compressed, the belly gibbous, tapering abruptly to a long quadrangular, prehensile tail; head with a distinct curved neck, placed nearly at a right angle with the direction of the body, surmounted by a compressed occipital crest, on the top of which is an angular, star-shaped coronet; top and sides of the head with spines. Physiognomy remarkably horselike, like that of a conventional knight at chess. Body and tail covered with bony plates, forming rings, those on the body each with six spines or tubercles, those of the tail with four; pectoral fins present, short and broad; anal minute, usually present; dorsal fin moderate, opposite the vent; egg pouch in the male a sac at the base of the tail, terminating near the vent.

175 Hippocampus hudsonius De Kay

Sea Horse; Horsefish

Hippocampus hudsonius De Kay, N. Y. Fauna, Fishes, 322, pl. 53, fig. 171, 1842; Storer, Syn. Fish. N. A. 239, 1846; Hist. Fish. Mass. 222, pl. XXXIII, fig. 4, 1867; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 907, 1883; Bean, 19th Rept. Commrs. Fish. N. Y. 243, 1890; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 777, 1896, pl. CXXI, fig. 327, 1900; Mearns, Bull. Am. Mus. Nat. Hist. X, 318, 1898; Bean, 52d Ann. Rept. N. Y. State Mus. 101, 1900.

Syngnathus hippocampus, Sea horse Pipefish. MITCHILL. Trans. Lit. & Phil. Soc. N. Y. I, 475, 1815.

Hippocampus heptagonus JORDAN & GILBERT. Bull. 16. U. S. Nat. Mus. 386. 1883, not of RAFINESQUE.

Body short and deep, much compressed, much shorter than the prehensile tail, which is three times as long as the head and more than three times greatest depth of body; snout as long as postorbital part of head, its depth two fifths of its length; eye circular, two fifths as long as the snout; interorbital space two thirds of diameter of eye; occiput with a five-pointed crest; a sharp spine above the gill covers on each side, one above the posterior part of the eye and one on each side of the throat; a blunt spine between the nostrils; the edges of the bony plates of body with the usual blunt spines. There are no cirri on the individual here described, but the species is said to have them sometimes. DeKay does not mention cirri in his account of the fish. Dorsal fin on 3½ rings; base of dorsal one half as long as head; longest dorsal ray one half as long as snout. D. 19; rings 12-32 to 36. Color light brown or dusky, without spots, but sometimes with pale grayish blotches which are sharply edged with paler and blackish. DeKay's specimens were light brown, with iridescent opercles, the iris yellow.

The sea horse is now known to occur on the New York and New Jersey coasts in moderate numbers during the summer months; its range extends from Cape Cod to Charleston. Mearns states that, during the summers of 1895 and 1896, a number of sea horses were taken by fishermen when netting shrimp in the eelgrass bordering the salt marshes near Consook island, at low tide. It has sometimes been found abundant in the nets in Gravesend bay, but has not occurred in large numbers since 1895. In 1898 only a few individuals were taken in Great South bay, and the same scarcity was observed by fishermen at Southampton L. I.

In captivity it thrives best in balanced tanks, but its life is short on account of parasitic attacks, which lead to swelling and ankylosis of the jaws. Its food in the aquarium includes Unciola and shrimp eggs. The sea horse excites popular interest on account of its singular shape, its prehensile tail,

and the fact that the male carries the eggs and protects the young in a pouch behind the vent. In this egg sac the young are protected till large enough to live independently, going out in search of food and returning to their shelter at pleasure.

Order ACANTHOPTERI

Spiny-rayed Fishes

Suborder SALMOPERCAE

Trout Perches

Family PERCOPSIDAE

Sand Rollers

Genus PERCOPSIS Agassiz

Body rather slender, pellucid, covered with rather thin scales; dorsal fin with two slender spines or simple rays; anal with one; scales roughest posteriorly; lateral line developed; preopercle entire or very nearly so; vertebrae 17+17=34. Atlantic slope, in cold or clear lakes and rivers.

176 **Percopsis guttatus** Agassiz

Trout Perch; Sand Roller

Percopsis guttatus AGASSIZ, Lake Superior, 286, pl. I, figs. 1, 2, 1850, Lake Superior; GÜNTHER, Cat. Fish. Brit. Mus. VI, 207, 1866; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 322, 1883; BEAN, Fishes Penna. 84, 1893; EVERMANN & KENDALL, Rept. U. S. Commr. Fish & Fisheries for 1894, 599, 1896 from THOMPSON; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 784, 1896, pl. CXXI, fig. 329, 1900.

Salmoperca pellucida THOMPSON, Appendix Hist. Vermont, 33, 1853, Lake Champlain.

Percopsis hammondi GILL, Proc. Ac. Nat. Sci. Phila. 151, 1864, Kansas.

Body rather long and moderately compressed, covered with thin ctenoid scales; head scaleless and without barbels; gill openings wide; opercles well developed; gill rakers short, tubercular; skull highly cavernous; mouth small; the margin of the upper jaw formed by the short nonprotractile intermaxillaries; no supplemental maxillary bone; small villiform teeth on the intermaxilliaries and mandible. The tongue is short, not free at tip. Pseudobranchiae developed. Six branchiostegals. The lateral line is continuous. The first dorsal over middle of body, with nine to 11 developed rays; adipose fin small; the anal and ventral eight rayed; caudal long, forked; pectorals narrow.

placed high. The stomach is siphonal and with numerous pyloric caeca, as in certain Salmonidae. The eggs are moderately large and are excluded through an oviduct. Air bladder present. The greatest hight of the body is about two ninths of the total without caudal, the head about three elevenths. The maxilla does not reach to the eye. The lower jaw is slightly included. Scales in lateral line 47 to 50.

Color pale olivaceous, or brown, the upper parts with rounded dark spots made up of minute dots; a silvery median stripe, becoming obsolete in front; peritoneum silvery.

The trout perch is a common fish in the Great lakes and their tributaries. It ranges north to Hudson bay, having been obtained at Moose Factory by Walton Hayden, also from Nelson river, near Rock Factory, by Dr Robert Bell. It has been obtained in the Delaware river by Dr C. C. Abbott, in the Potomac by Prof. Baird, in the Ohio by Drs Jordan, Henshall and Bean, and Dr Gill has recorded the species from Kansas.

Dr Meek obtained no specimens from Cayuga lake, but he has no doubt it is found there. The U. S. Fish Commission had it from Lake Ontario, Nine Mile point, near Webster N. Y., in 1893; also from Cape Vincent and Grenadier island. The fish is a resident of Lake Champlain, in which it was first discovered by Thompson, several years before Agassiz secured it in Lake Superior.

The trout perch is too small to be valuable for food, but is doubtless an excellent bait. It is one of the most remarkable fishes of our fresh waters, combining as it does the characters of the salmon and some of the perches. Its name indicates this singular relationship. It is voracious, takes the hook freely, and spawns in the spring.

Suborder XENARCHI

Family APHREDODERIDAE

Pirate Perches

Genus APHREDODERUS Le Sueur

Body oblong, elevated at the base of the dorsal, compressed behind, the head thick and depressed, the profile concave;

caudal peduncle thick; mouth moderate, somewhat oblique, the lower jaw projecting, maxillary reaching to anterior border of the eye; teeth in villiform bands on jaws, vomer, palatines, and pterygoids; premaxillaries not protractile, maxillaries small, without evident supplemental bone; preopercle and preorbital with their free edges sharply serrate, opercle with a spine; bones of skull somewhat cavernous, sides of the head scaly; lower pharyngeals narrow, separate, with villiform teeth; gill membranes slightly joined to the isthmus anteriorly; gill rakers tuberclelike, dentate; pseudobranchiae obsolete; gills four, a small slit behind the fourth; branchiostegals six; scales moderate, strongly ctenoid, adherent, lateral line imperfect or wanting; vent always anterior, its position varying with age, from just behind the ventral fins in the young to below the opercle in the adult; dorsal fin single, median, high, with but three or four spines, which are rapidly graduated, the first being very short; anal small, with two slender spines; ventral fins thoracic, with a very short spine, the number of soft rays usually seven; caudal fin rounded behind; air bladder simple, large, adherent to the walls of the abdomen; vertebrae 14+15; pyloric caeca about 12. A single genus, with probably but one species, confined to the United States.

177 Aphredoderus sayanus (Gilliams)

Pirate Perch

Aphredoderus sayanus De Kay, N. Y. Fauna, Fishes, 35, pl. 21, fig. 62, 1842; near Philadelphia Pa.

Aphredoderus gibbosus Le Sueur, in Cuvier & Valenciennes, Hist. Nat. Poiss. IX, 448, pl. 278, 1833.

Aphredoderus sayanus De Kay, N. Y. Fauna, Fishes, 35, pl. 21, fig. 62, 1842; Storer, Syn. Fish. N. A. 47, 1846; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 460, 1883; Bean, Bull. U. S. F. C. VII, 145, 1888; Fishes Penna. 101, 1893; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 786, 1896, pl. CXXII, fig. 331, 1900; Eugene Smith, Proc. Linn. Soc. N. Y. No. 9, 33, 1898; Bean, 52d Ann. Rept. N. Y. State Mus. 101, 1900. Patchogue, Long Island.

The body is moderately stout, oblong, somewhat compressed posteriorly. Scales ctenoid. The dorsal fin is continuous, with three or four spines and 11 soft rays. The anterior spines much the shortest. The anal has two spines and six rays. The mouth

is rather large for the size of the fish; the lower jaw somewhat longer than the upper; the maxilla reaches to front of eye; jaws, vomer and palatine bones with villiform bands of teeth; lateral line wanting. The depth of the body is two sevenths and length of the head one third of the total without caudal. The eye is two ninths as long as the head. The origin of dorsal is much in advance of the middle of the total length; the pectorals do not reach as far back as the ventrals; ventrals more than one half length of head; the longest anal spine three sevenths of length of head; the caudal rounded. Scales in 48 to 55 series. The color is variable, sometimes olivaceous, at other times dark brown with numerous dark punctulations; a dark bar at the base of the caudal followed by a light one.

The pirate perch ranges from New York westward to Minnesota, and in the Mississippi valley it extends to Louisiana. In Pennsylvania the species occurs in Lake Erie, probably in tributaries of the Ohio and in the lower Delaware. Common in East lake at Patchogue and in the head of Swan river.

The farthest place east from which it is known appears to be Suffolk county on Long Island.[1]

This is one of the most interesting little fishes of the fresh waters, particularly because the position of the vent varies with age. In the young it is behind the ventrals, while in the adult it is in the throat.

The fish grows to a length of 4 inches. Nothing is recorded about its habits except that it is very voracious and feeds at night. It is common in sluggish streams and ponds in the shelter of aquatic plants. In captivity it has never been observed to feed; perhaps it takes food, however, at night, but it does not thrive in the aquarium.

Suborder PERCESOCES

Family ATHERINIDAE

Silversides

Genus MENIDIA (Bonaparte) J. & G.

Body elongate, more or less compressed; head oblong, compressed; belly before ventrals, more or less rounded in section.

[1] *See* Ayres. Enumeration of the Fishes of Brookhaven L. I. etc. Bost. Jour. Nat. Hist. 1844, IV.

not compressed to an edge; mouth small, the gape curved, very oblique, usually not reaching the eye; lower jaw short and weak; maxillary slipping entirely under preorbital; jaws each with a band of simple, usually villiform teeth; premaxillaries very freely protractile, their spines comparatively long, nearly equal to the eye, extending backward beneath a fold of skin, which connects the basis of the maxillaries; posterior part of the premaxillaries broad; no teeth on vomer or palatines; both dorsals short, the usual radial formula being D. V–1, 8, first dorsal usually, but not always in front of anal; soft dorsal and anal scaleless; scales rather large, entire.

178 **Menidia gracilis** (Günther)

Slender Silversides

Atherinichthys gracilis Günther, Cat. Fish. Brit. Mus. III, 405, 1861.
Menidia gracilis Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 797, 1896, Specimens from St George's Island, Potomac River.

The origin of the anterior dorsal fin is opposite to the vent, exactly in the middle of the distance between the end of the snout and the base of the caudal. The distance between the origins of the two dorsal fins is somewhat more than one half of that between the origin of the posterior and the caudal. The hight of the body is contained nine times in the total length, the length of the head five and one half times. The silvery band is narrow, and occupies a part of the fourth series of scales. Scales with the margin entire. Caudal lobes equal in length; caudal somewhat longer than the pectoral, and rather shorter than the head. 31 lines long. Probably young. Habitat unknown. D. IV, I, 8; A. I, 19. Scales 9–40. (After Günther)

The specimens above referred to, from St George's island, lower Potomac river, were obtained by Dr Hugh M. Smith, of the U. S. Fish Commission, in the summer of 1890.

The specimens were compared with the published descriptions of M. beryllina (Cope) and were found to differ in some minor details, the dorsal formula being V, I, 10 instead of V, I, 11, the anal rays averaging I, 16 or I, 17 instead of I, 18, and the silvery stripe apparently taking a different course.

Some large examples (3¼ inches long) of the Potomac river silverside no. 43125, U. S. National Museum, collected by W. P. Seal, apparently in 1890, agree very well with the description of beryllina and also with the characters of Dr Smith's specimens. It is probable that Cope's name must be associated with this fresh-water form, and not the name gracilis of Günther. None of our individuals have four dorsal spines, and there is no certainty that Dr Günther's type came from the United States. I have, however, followed Drs Jordan and Evermann in their identification.

The species is said to range from Woods Hole Mass. to Albemarle sound.

179 Menidia beryllina (Cope)

Fresh water Silversides

Chirostoma beryllinum Cope, Trans. Am. Phil. Soc. 403, 1866, Potomac River, at Washington, D. C.

Menidia beryllina Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 408, 1883; Bean, Fishes Penna. 100, 1893; 52d Ann. Rept. N. Y. State Mus. 102, 1900.

Menidia gracilis beryllina Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 797, 1896, pl. CXXIV, fig. 338, 1900.

The body is shorter than usual among the silversides. The spinous dorsal is well separated from the soft dorsal, and its posterior margin extends almost to the vertical from the first anal ray. The ventral reaches to below the first ray of the dorsal. The length of the head is contained four and one fourth times in the total length without caudal. The eye large, orbit one third as long as the head; mouth small; the mandible slightly longer than the maxilla and slightly curved; greatest depth of body one sixth of total length without caudal. Scales in lateral line 36, transverse series 10. The lateral line is represented by a pore on the anterior part of the exposed portion of each scale, except on the caudal peduncle, where it runs through a groove. D. V–I, 11; A. I, 18; V. I, 5; P. 15. The caudal is deeply forked.

Pale olivaceous in color with a silvery lateral band, on two and one half rows of scales, with a lead colored margin. The anal base is lead colored; sides of the head silvery.

This species corresponds in many particulars with Menidia peninsulae of Goode & Bean, but in that species the silvery streak covers only one and one half rows of scales. The soft dorsal in M. peninsulae appears to show considerable variation in the number of rays.

The fresh-water silversides was first described from the Potomac river, where it has recently been rediscovered in abundance, both in fresh and brackish water. It is very common at Water Mill L. I. and in fresh-water tributaries of Great South bay. Several examples were seined in 1898 in salt water at Clam Pond cove.

In some of the Water Mill specimens the following characters were noted: D. V, I, 10; A. I, 16–17. Scales 8–40.

Its associates in fresh water at Water Mill were: Fundulus diaphanus, Lucania parva, Eupomotis gibbosus, and Lucius reticulatus. In 1898 it was obtained also in Shinnecock bay, Scallop pond (Peconic bay) and Mecox bay. The localities in Great South bay were: Swan river, south side of Great South bay, Horsefoot creek and Bellport Lifesaving station.

180 Menidia notata (Mitchill)

Silversides; Friar; Whitebait

Atherina notata Mitchill, Trans. Lit. & Phil. Soc. N. Y. I. 446, pl. IV, fig. 6, 1815, New York; De Kay, N. Y. Fauna, Fishes, 141, pl. 28, fig. 88, 1842, New York; Storer, Hist. Fish. Mass. 87, pl. XVI, fig. 1, 1867.

Atherina viridescens Mitchill, op. cit. 447, 1815, New York.

Chirostoma notatum Goode & Bean, Bull. Essex Inst. XI, 21, 1879, and of many other authors.

Atherina menidia De Kay, op. cit. 142, pl. 74, fig. 236, 1842, New York; not of Linnaeus.

Atherinichthys menidia and *notata* Günther, Cat. Fish. Brit. Mus. III, 406, 1861.

Atherinopsis notatus Baird, Ninth Ann. Rept. Smith. Inst. 338, 1855.

Menidia notata Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 407, 1883; Bean, Bull. U. S. F. C. VII, 146, 1888; 19th Rept. Commrs. Fish. N. Y. 271, 1890; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 800, 1896; Eugene Smith, Proc. Linn. Soc. N. Y. No. 9, 32, 1898; Bean, 52d Ann. Rept. N. Y. State Mus. 102, 1900.

Body elongate, compressed, its greatest depth contained six and one third times in total length without caudal, and equaling

three fourths of length of head; the caudal peduncle long and slender, its least depth about one third the length of head; width of body about one half the length of head; head short, pointed, its length one fifth of the total without caudal; snout slightly shorter than eye, about three and one fourth in length of head; margin of upper jaw formed chiefly by the curved premaxillary, which is nearly as long as the eye; eye equal to interorbital space, and one third as long as the head; two rows of scales under the eye; exposed part of maxilla two fifths as long as the eye; dorsal origin nearly midway between tip of snout and base of middle caudal rays, base of dorsal about as long as eye, longest dorsal spine one third as long as the head, fifth dorsal spine one fifth as long as head, interspace between the two dorsals contained $10\frac{1}{2}$ times in total length without caudal, second dorsal base one half as long as head, longest dorsal ray equal to eye and snout combined, last dorsal ray equal in length to snout; anal origin under end of spinous dorsal, also under 25th scale of lateral line, anal base three elevenths of total length without caudal, corresponding with 15 rows of scales, longest anal ray equal to snout and eye combined, last anal ray one fourth as long as head. The vent is under the last spine of the dorsal. The ventrals are distant from the end of the head a space equal to length of head, length of ventral equal to snout and eye combined, 15 rows of scales between ventral origin and throat. Middle caudal rays about one half as long as head, external rays five sixths as long as head, the fin deeply forked. The silvery band nowhere covering more than the width of one scale, though not limited to one row.

Translucent green; lateral band silvery, mostly on the level of the eye, its width less than one half the diameter of eye. Scales of upper parts with dark dots along their edges; chin speckled.

The common silversides grows to a length of 6 inches.

The silversides was first made known by Dr Mitchill under the name of small silverside, Atherina notata, and he described the young of the same species as the green-sided silverside, Atherina viridescens. Dr De Kay states that the

silversides was known in the harbor of New York as the anchovy and the sand smelt. Friar is a New England name for the species; capelin is in use about Boston, and merit fish in the vicinity of Watch Hill. Sperling is a name recently applied to this species by some fishermen, and we have known persons to offer the silversides as whitebait. In Great South bay it is known as shiner.

The silversides is known to occur on the coast from Maine to Virginia. It is one of the most abundant of the small fishes in our waters, swimming in immense schools made up of fish of different sizes, and it forms a considerable part of the food of more valuable species, such as the mackerel, bluefish, weakfish and flounders, and is very much in demand as a bait for hook and line fishing. We seined the silversides in all parts of Great South bay, and found it to be one of the most abundant and characteristic species.

The common silversides, or spearing, lives in Gravesend bay almost all the year, hibernating in spring holes in winter. It is well suited for a captive life and can endure a temperature of 71½° in the salt water.

In 1898 the species was found for the state museum at all Long Island localities visited, Peconic bay, Mecox bay, the ocean at Southampton, and throughout Great South bay. Small individuals are sold in the markets as whitebait. In the time of De Kay the fish was called anchovy and sand smelt and was esteemed a savory food. 20 years before he wrote of the fishes of New York, it was caught from the wharves and sold for bait.

Genus KIRTLANDIA Jordan & Evermann

This genus is close to Menidia, but differs from it in having the scales laciniate and the dorsal and anal fins scaly. Three species known from the United States and Martinique.

181 Kirtlandia vagrans (Goode & Bean)

Rough Silversides

Chirostoma vagrans GOODE & BEAN, Proc. U. S. Nat. Mus. 148, 1879. Florida.
Menidia vagrans JORDAN & GILBERT, Proc. U. S. Nat. Mus. 267, 1882, Bull. 16, U. S. Nat. Mus. 407, 1883.

Menidia vagrans laciniata SWAIN MS in JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 908, 969, 1883, Beaufort, N. C.; JORDAN & GILBERT, Proc. U. S. Nat. Mus. 589, 1883.

Menidia laciniata SWAIN in JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 969, 1883; BEAN, Bull. U. S. F. C. VII, 146, 1888, Great Egg Harbor Bay, N. J.; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 795, 1896; BEAN, 52d Ann. Rept. N. Y. State Mus. 102, 1900.

Kirtlandia vagrans JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 794, 1896, pl. CXXIV, fig. 336, 1900.

Kirtlandia laciniata JORDAN & EVERMANN, op. cit. 795, 1896; BEAN, 52d Ann. Rept. N. Y. State Mus. 102, 1900.

Hight of the body contained five and one half to six times in length without caudal, and six and two thirds times in total length, considerably less than length of head and length of pectoral; origin of spinous dorsal fin situated behind a point midway between origins of ventral and anal fins and opposite the middle of the interspace between anal fin and vent; eye longer than snout, one third as long as the head, and less than width of interorbital space; mouth slightly protractile, lower jaw equal to length of eye; length of head contained four and three fourths times in total length without caudal, and equal to length of pectoral; pectoral reaching only a very little beyond origin of ventral when extended; ventral not reaching to vent, its length one half the length of head; anal base about as long as the head; caudal slightly forked, the lobes equal; vertical fins excessively scaly; scales of body large, laciniate, some of the exposed edges with 12 points. D. IV to V–I, 7; A. I, 18 to 19; V. I, 7; P. 14. Scales 7–48 to 50. Lateral silvery stripe covering the lower two thirds of the third series of scales and the upper one third of the fourth series.

Light greenish above; sides and belly silvery; tip of snout and of lower jaw yellow mingled with blackish; scales on the back with several to many dark spots on the free edges, these usually forming streaks; caudal yellow with dark points, its margin dusky; dorsal and pectorals dusky; lower fins pale, the anal with dark points at its base.

As here described, the species includes M. laciniata (Swain) which has been recorded from New Jersey and North Carolina. The only difference discoverable between them is in

the number of the dorsal spines, which is generally four in laciniata, but sometimes five, as observed in examples from Great Egg Harbor bay, N. J., no. 45158 U. S. National Museum.

The rough silversides grows to the length of 4 inches; it is not important for food, but serves as food for the larger fishes. It was found abundant at Somers Point N. J. in August 1887, where it had previously been unknown. The largest individual taken in Great Egg Harbor bay, $4\frac{1}{3}$ inches long, was secured at Longport N. J.

The only example so far known in New York waters was caught in Mecox bay, L. I. Aug. 1, 1898. Though the bay was seined repeatedly afterward in search of the fish, no other specimens were seen. The following notes were obtained: D. V, I, 7; A. I, 20; P. 14; V. I, 5. Scales 7–47.

Genus LABIDESTHES Cope

This genus differs from Menidia chiefly in the prolongation of the jaws, both of which are produced into a short depressed beak. The scales are small as in Leuresthes and Basilichthys, their edges entire.

182 Labidesthes sicculus (Cope)

Brook Silversides; Skipjack; Glassfish

Chirostoma sicculum Cope, Proc. Ac. Nat. Sci. Phila. 81, 1865, Cresse Isle, Detroit River.

Labidesthes sicculus Cope, Proc. Am. Phil. Soc. Phila. 40, 1870; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 406, 1883; Meek, Ann. N. Y. Ac. Sci. IV, 312, 1888, Montezuma, N. Y.; Bean, Fishes Penna. 100, 1893; Bull. Am. Mus. Nat. Hist. IX, 357, 1897; Chautauqua Lake; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 805, 1896.

The body is slender and elongate, its depth one sixth or one seventh of the total without caudal. Length of head about two ninths of total; eye two sevenths of length of head, two thirds of length of snout. D. IV, I, 11; A. I, 23. Scales 14–75. Caudal deeply forked.

Color olivaceous, the fish in life translucent, the upper parts with small black dots, the silvery lateral band edged above with lead color and covering one row and two half rows of scales; cheeks silvery.

The genus Labidesthes has a very oblique mouth, with the upper jaw flat above and concave beneath, the intermaxillaries forming a rooflike beak. The mandible is convex.

The brook silversides, or skipjack, is found in streams and ponds in the Ohio and Mississippi valleys. It has also been discovered recently in some of the southern states, from South Carolina to Florida. In New York it is recorded from near Montezuma, from Chautauqua lake, where it is called silver skipjack and glassfish, and from Lake Ontario. Dr Meek says it is not found near Ithaca. The U. S. Fish Commission collectors obtained it at the following places in New York:

Stony Island	July 2 and 3
Great Sodus bay	Aug. 6
Long pond, Charlotte	Aug. 17
Sandy creek, North Hamlin	Aug. 20

The fish grows to the length of 4 inches and is important only as food for larger species. It has been kept in the aquarium, but does not endure transportation or captivity. The brook silversides is a surface swimmer, and the name skipjack is derived from its habit of skipping out of and along the surface of the water. It abounds in "clear pools left in summer by the fall of the waters in the streams, which has filled them."

Family MUGILIDAE

Mullets

Genus MUGIL (Artedi) Linnaeus

Body oblong, somewhat compressed, covered with large scales, head large, convex, scaled above and on sides; mouth small, subinferior, the lower jaw angulated; jaws with one or a few series of short, flexible, ciliiform teeth, no teeth on vomer or palatines; eye large, with a large adipose eyelid, which is little developed in the young; stomach muscular, like the gizzard of a fowl. Species very numerous, living on mud and running in great schools along the shores and in brackish lagoons of all warm regions. We here exclude from Mugil the old world group, Liza (type Mugil capito) similar in habit

to Mugil, but lacking the adipose eyelid. (After Jordan & Evermann)

183 Mugil cephalus Linnaeus

Striped Mullet

Mugil cephalus Linnaeus, Syst. Nat. ed. X, I, 316, 1758, Europe; Jordan & Swain, Proc. U. S. Nat. Mus. 263, 1884; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 811, 1896, pl. CXXVI, fig. 343, 1900; Bean, 52d Ann. Rept. N. Y. State Mus. 103, 1900.

Mugil albula Linnaeus, Syst. Nat. ed. XII, 520, 1766, Charleston, S. C.; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 403, 1883; Bean, 19th Rept. Comm. Fish. N. Y. 272, pl. XXI, fig. 26, 1890.

Mugil lineatus Mitchill, Cuvier & Valenciennes, Hist. Nat. Poiss. XI, 96, 1836, New York; De Kay, N. Y. Fauna, Fishes, 144, pl. 15, fig. 42, 1842, New York; Storer, Hist. Fish. Mass. 39, pl. XVI, fig. 4, 1867.

Body fusiform, elongate, stout, its greatest width contained one and three fourths times in length of head and equal to length of ventral fin, greatest depth of body one fourth of total length without caudal; snout narrow and somewhat pointed, its length about one fifth of length of head, its profile scarcely more convex than profile of lower jaw; interorbital space little convex, its width one half length of head; thickness of upper lip scarcely more than one third of length of premaxillary; space between the mandibles oblanceolate, its greatest width about one fifth of its length; eyes covered by an adipose membrane leaving a free space only about as wide as the pupil; length of head contained three and one half to four times in total length without caudal; eye about two sevenths as long as the head; teeth in upper jaw in a rather broad band, the outer row slightly enlarged, teeth in lower jaw similar but much smaller; scales smaller than in M. curema, about 24 or 25 rows of scales between tip of snout and origin of spinous dorsal, some scales on top of head slightly enlarged, soft dorsal and anal fins almost scaleless; origin of spinous dorsal midway between tip of snout and base of middle caudal rays, about over the middle of the ventral, base of spinous dorsal one third as long as the head, first spine longest, one half as long as the head, last spine one half as long as the first, interspace between dorsals about one half length of head, upper margin of soft dorsal deeply concave, base of the fin a little more than one third of

length of head, longest ray one half the length of head, last ray one fourth the length of head; caudal deeply forked, its middle rays one half as long as the head, its external rays nearly as long as the head; pectoral reaches to the 11th row of scales from its axil, about as far back as the end of the ventral appendage, its length two thirds of length of head; ventral origin midway between tip of snout and fifth ray of anal, its length four sevenths of length of head, the fin extending to below the end of the base of spinous dorsal, the tip distant from the anal origin a space about equal to the length of the fin. D. IV–I, 8; A. III, 8. Scales 14–42. Color, dark bluish above; the sides silvery; exposed part of scales, specially of eight or 10 upper series, darker than body color, causing a striped appearance; belly and lower part of sides yellowish; ventral fins yellowish; soft dorsal, anal and ventrals dusky; tip and base of pectoral dusky.

The striped mullet grows to the length of 2 feet, but the average size in New York waters is much less.

The fish is known in Great South bay as mullet and jumping mullet; the name mullet is applied to it also in the Gulf of Mexico, and is in general use along the east coast; it is known in the Chesapeake as mullet or fatback. The latter name is probably applied to more than one species.

The striped mullet is known on our coast from Cape Cod to the Gulf of Mexico. The young are much more abundant than the adults. In Great South bay we found the species not uncommon; two examples were taken at the mouth of Swan creek, September 12. Several schools were present. We were informed that they appear occasionally, and one gentleman of Patchogue was very successful in taking this and its allied species with hook and line. De Kay states that the striped mullet was first observed in New York waters by Dr Mitchill. He found them in the markets in the beginning of September. This species is one of our choice food fishes. It is not uncommon in September in Great Egg Harbor bay, N. J., but we were informed that large specimens are never taken in that body of water.

In 1898 the striped mullet was not abundant in the waters seined till fall; the great schools were absent till October. Several individuals were obtained in Mecox bay August 2 and a larger number in Clam Pond cove, Great South bay, August 22.

The young of this species are abundant in Gravesend bay in midsummer; larger ones appear in September and October. One winter, some years ago, mullet hibernated in the mud in Sheepshead bay and were taken with eel spears. The mullets feed and thrive most of the year in captivity, but will not survive the intense heat of summer. In the aquarium their food includes hard clam and shrimp.

In 1883 Jordan and Gilbert established a genus Querimana for "little mullets with but two spines in the anal fin and with the teeth in the jaws less ciliiform than in Mugil. Adipose eyelid wanting; preorbital serrate." The genus was based on Myxus harengus of Günther. Querimana is nothing more than the young of Mugil. The only good character by which it was distinguished is the presence of two anal spines instead of three; in all other respects Querimana and Mugil agree perfectly. As a matter of fact, all young Mugils pass through a Querimana stage in which only two of the three anal spines are developed, the adipose eyelid is rudimentary and the teeth are comparatively stouter than in the adult. The third anal spine of Mugil is really a simple articulated ray till the fish reaches a length varying from about 40 mm to 50 mm. The first simple ray of the anal becomes a spine by the breaking off at an articulation, the subsequent sharpening of the point, and the deposit of hard material in the articulations, thus forming a somewhat slender, but perfect, spine.

This fact of development was carefully studied in large series of specimens in the U. S. National Museum, and it is both interesting and important from the fish cultural as well as the systematic standpoint. In Mugil cephalus one example, 41 mm long, shows the third anal spine very plainly; it is well developed and has a sharp point, but several articulations still

remain. Other examples of equal length have the first simple anal ray scarcely developed into a spine, and in still others this ray does not take on the character of a spine at all. Querimana harengus, the type of the genus, is the young of Mugil curema, and Q. gyrans is the immature Mugil trichodon. A reexamination of the types of Querimana gyrans shows the presence of 33 rows of scales in some examples instead of 29, as originally recorded.

184 Mugil curema Cuv. & Val.

White Mullet

Mugil curema Cuvier & Valenciennes, Hist. Nat. Poiss. XI, 87, 1836, Brazil; Martinique; Cuba; Bean, Bull. U. S. F. C. VII, 145, 1888; 19th Rept. Comm. Fish. N. Y. 272, pl. XXI, fig. 26, 1890; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 813, 1896, pl. CXXVI, fig. 344, 1900; Bean, 52d Ann. Rept. N. Y. State Mus. 103, 1900.

Mugil petrosus Cuvier & Valenciennes, op. cit. 88, 1836, Brazil to New York; De Kay, N. Y. Fauna, Fishes, 147, 1842.

Mugil brasiliensis Günther, Cat. Fish. Brit. Mus. III, 431, 1861; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 403, 1883.

Body shaped like that of the striped mullet, its width equaling two thirds of length of head, its greatest depth contained three and one half to three and five sixths times in total length without caudal; least depth of caudal peduncle equal to one half the length of head; snout nearly as in M. cephalus, sometimes with its outline more declivous, its length one fifth of length of head; interorbital space slightly convex, its width nearly one half the length of head; thickness of upper lip scarcely one third of length of upper jaw, space between the mandibles nearly lanceolate, its width one sixth of its length; eyes covered with an adipose membrane leaving only a space about as wide as the pupil exposed, eye about two sevenths as long as the head; head one fourth, or nearly one fourth, of total length without caudal; teeth in outer row on premaxilla somewhat enlarged, distant; scales rather large, about 22 rows between tip of snout and origin of first dorsal; soft dorsal and anal densely scaled, origin of spinous dorsal midway between tip of snout and base of external caudal rays, directly over the 10th row of scales, counting from the axil of the pectoral, the first spine nearly two thirds as long as the head, the last spine less than one half

as long as the first, interspace between the dorsals equal to three fifths of length of head, upper margin of soft dorsal deeply concave, base of fin equal to length of postorbital part of head, the longest ray three fifths of head, the last ray one fourth the length of head; caudal deeply forked, its middle rays one half as long as the head, its external rays equal to the head; pectoral reaches the eighth row of scales, its length equal to head without snout; ventral origin midway between tip of snout and third ray of anal, its distance from vent equal to its own length, which is two thirds of length of head; about 24 rows of scales between the head and the anal origin, base of anal three fifths as long as the head, longest anal ray equal to length of postorbital part of head, last anal ray two sevenths of length of head. D. IV–I, 8; A. III, 9. Scales 12–38.

Color silvery, bluish above; no dusky streaks along the sides in life, but faint streaks are evident after preservation in spirits; a small dark blotch at base of pectoral; caudal pale, yellowish at base, dusky at tip; anal and ventrals yellowish; two yellow blotches on side of head.

The white mullet reaches the length of 1 foot. On the Atlantic coast it ranges from Cape Cod to Brazil; in the Pacific it is recorded from California to Chile. It is a very important food fish.

The white mullet appears with the striped species, but is less abundant in Gravesend bay and is smaller in size. The young were taken in Great South bay in August 1898, and half grown individuals were abundant in September and October. Adults were scarce.

Dr Mitchill calls this the summer mullet. He records a specimen that weighed 2½ pounds, the heaviest coming under his observation. DeKay found the species in New York markets in July and August.

185 Mugil trichodon Poey

Whirligig Mullet (young); Fantail Mullet

Mugil trichodon Poey, Ann. Lyc. Nat. Hist. N. Y. XI, 66, pl. 8, figs. 4 to 8, 1875, Cuba; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 816, 1896.

Mugil brasiliensis Jordan & Swain, Proc. U. S. Nat. Mus. 270, 1884; not of Agassiz *fide* Jordan & Evermann.

Querimana gyrans JORDAN & GILBERT, Proc. U. S. Nat. Mus. 26, 1884; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 818, 1896.

Body robust, its greatest depth three elevenths of the total length without caudal; head short, its length contained four and one fifth times in total to caudal base; snout moderately acute, its upper and lower profiles equally oblique; interorbital space little convex, its width two fifths of the length of the head; upper lip remarkably thick; space between the mandibles underneath narrow, oblanceolate, rather pointed behind; an adipose membrane covering all but the central part of the eye; teeth comparatively large and wide set, about as long as the nostril; about 21 rows of scales between origin of spinous dorsal and tip of snout, soft dorsal and anal densely scaled, the margin of soft dorsal concave, the second, and longest, ray two and three fourths times as long as the seventh; anal similar to soft dorsal; the pectoral short, not reaching nearly to vertical from front of spinous dorsal; caudal large, deeply forked. D. IV–I, 8; A. III, 8. Scales 33–11.

Upper parts dusky, olivaceous, with bluish reflections, lower parts silvery; scales without dusky spots; a dark blotch at base of pectoral; dorsals and caudal pale, the dorsals with minute dark points, caudal with a dark margin; anal and ventrals yellowish; pectorals pale, with fine brown punctulations.

The fantail mullet ranges from Brazil to the Florida Keys and Cuba. The young, which is Querimana gyrans of Jordan & Gilbert, migrates northward in summer to Cape Cod; it has been recorded from Long Island and the vicinity of Woods Hole Mass.

The species reaches the length of 10 inches.

Family SPHYRAENIDAE

Barracudas

Genus SPHYRAENA (Artedi) Bloch & Schn.

Body elongate, subterete, covered with small cycloid scales; head very long, pointed, pikelike, scaly above and on sides; mouth horizontal, large; jaws elongate, the lower considerably projecting, upper jaw nonprotractile, its border formed by the

premaxillaries, behind which are the broad maxillaries, large, sharp teeth of unequal size on both jaws and on palatines; none on the vomer; usually a very strong, sharp canine near the tip of the lower jaw; opercular bones without spines or serratures; gill openings wide, the gill membranes not united, free from the isthmus; gill rakers very short or obsolete; branchiostegals seven; gills four; pseudobranchiae well developed; air bladder large, bifurcate anteriorly; many pyloric caeca; lateral line well developed, straight; pectoral fins short, placed in or below the line of the axis of the body; ventrals I, 5, abdominal, in advance of the middle of the body; first dorsal over ventrals, of five rather stout spines, second dorsal remote from first dorsal, similar to and opposite anal; caudal fin forked; vertebrae 24; first superior pharyngeal absent, second, third, and fourth separate, with teeth, lower pharyngeals separate.

186 Sphyraena guachancho Cuv. & Val.

Long Barracuda

Sphyraena guachancho Cuvier & Valenciennes, Hist. Nat. Poiss. III, 342, 1829, Havana; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 824, 1896.

Sphyraena guaguancho Goode & Bean, Proc. U. S. Nat. Mus. II, 146, 1880; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 411, 1883.

Sphyraena guaguanche Poey, Memorias, II, 166, 1860; Meek & Newland, Proc. Ac. Nat. Sci. Phila. 70, 1884.

Sphyraena güntheri Haly, Ann. & Mag. Nat. Hist. XV, 270, 1875, Colon.

Body moderately elongate, subcylindric, its greatest depth one seventh of the total length without caudal, its width two thirds of its depth and one third of length of head; the caudal peduncle stout and not elongate, its least depth one fourth the length of head. The head is long, nearly one third of total without caudal, its width two sevenths of its length; the lower jaw projects a space one half as long as the iris, the top of head flat and with a long and well marked median groove; the interorbital space equal to iris; the maxilla broadly expanded and abruptly bent downward, its width at the posterior end one fourth of its length, its end reaching about to front of orbit; mandible as long as head without postorbital part; preocular ridge three fourths as long as iris;

premaxillary teeth small, about 43 developed in the individual examined (sometimes 35 to 40), front of the premaxillaries with four large canines, the posterior pair slightly larger, one third as long as the eye; three large, bladelike fangs on each side of palatines; a large compressed fang at symphysis of lower jaw, mandible with about 17 moderately large, compressed teeth on each side; eye one sixth of length of head, one half postorbital part of head; dorsal origin at a distance from snout equal to three times length of snout, base of spinous dorsal one third length of head from tip of upper jaw, second spine longest, nearly one third of length of head, fifth spine one half as long as the second, interspace between first and second dorsal equal to snout and eye combined, base of second dorsal two sevenths of length of head, including lower jaw, longest ray as long as base of fin, last ray one fifth of length of head; ventral a little in advance of spinous dorsal, its distance from the head equal to length of pectoral, its length two sevenths of length of head; anal origin under middle of dorsal base, anal base one fourth the length of head, longest anal ray equal to ventral, last ray one half the postorbital part of head; middle caudal rays very short, external rays as long as snout and eye combined; pectoral as long as postorbital part of head; top of head with minute embedded scales; cheeks and opercles scaly, but interopercle and posterior half of opercle naked. B. VII, D. V-I, 9; A. I, 8; V. I, 5; P. I, 12. Scales 15 to 16–112 to 121–13 to 17.

Color pale green above, soft dorsal yellowish; anal and ventral fins chiefly pale but basal part of ventral dusky; pectoral and caudal dusky at tip; dark punctulations on spinous dorsal and on upper part of body. The specimen described is no. 30015, Jamaica, in the U. S. national museum.

An individual $21\frac{3}{5}$ inches long was taken at Woods Hole Mass., and is described by Goode and Bean in *Proceedings of the U. S. National Museum*, II, 147, 1880. The species ranges from the West Indies to Florida, and occasionally northward in summer to Cape Cod.

187 Sphyraena borealis De Kay

Northern Barracuda

Sphyraena borealis De Kay, N. Y. Fauna, Fishes, 39, pl. 60, fig. 196, 1842, New York; Meek & Newland, Proc. Ac. Nat. Sci. Phila. 75, 1884; Bean, Bull. U. S. F. C. VII, 145, 1888; 19th Rept. Comm. Fish. N. Y. 271, 1890; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 825, 1896.

Sphyraena spet Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 411, 1883; not of Häuy.

Body moderately elongate and compressed, its greatest depth equal to length of snout, and contained seven and one half times in total length without caudal its width equaling two sevenths of length of head; caudal peduncle subterete and tapering, its least depth one fifth of length of head. The head is one third of total length without caudal, its width one fourth of its length, the lower jaw projecting a space equal to pupil, top of head slightly convex, a very shallow median groove, the interorbital space equal to length of eye; maxilla broadly expanded posteriorly, its greatest width one fourth of its length, its end not reaching front of orbit by a space two thirds as long as the eye; mandible as long as snout and eye combined; preocular ridge two thirds as long as the eye, not very prominent; premaxillary teeth small, smaller anteriorly, about 45 in number, front of the premaxillaries with three large canines on each side, one of them much larger than the others, one third as long as the eye; two large fangs on one side of the palatines, three on the other, followed on each side by three smaller teeth; a large, compressed fang at the symphysis of lower jaw, mandible with 10 to 12 teeth, increasing in size and becoming more widely separated posteriorly; eye equal to interorbital width and its length contained six and one fourth times in length of head; dorsal origin at a distance from tip of snout equal to a little more than three times length of snout, base of spinous dorsal nearly one third as long as the head, second dorsal spine longest, about one third length of head, last dorsal spine one half of postorbital part of head, interspace between dorsals one half of length of head, base of second dorsal equal to longest dorsal ray and two sevenths of length of head, last dorsal ray equal to long diameter of eye,

and one seventh of length of head; ventral under the second spine of the dorsal, its distance from the head one half of length of head, and much greater than length of pectoral; anal origin under fourth ray of second dorsal; the anal base two sevenths of length of head, longest anal ray equal to base of anal fin, last ray three fourths of diameter of eye, one third of postorbital part of head; middle caudal rays very short, external rays one half as long as the head; pectoral equal to postorbital part of head; top of head with numerous minute, embedded scales and with many series of mucous pores; cheeks and opercles scaly and without naked spaces. B. VII; D. V–II, 9; A. III, 8; V. I, 5; P. I, 12. Scales 13–126–13.

Color greenish above; lateral line yellow; lower parts silvery; iris golden; young with dusky blotches on the back and along the lateral line.

This fish seems to have been unknown to the early writers on New York fishes, the species not appearing in any publication earlier than De Kay's *New York Fauna*, in 1842. Dr De Kay calls it the northern barracuda, to distinguish it from the southern species.

The young barracuda have been taken from Cape Cod to New Jersey, the southern limit being indefinite. Individuals of 1 foot in length have been rarely seen, but examples measuring from 2 to 6 inches are extremely common as far north as Cape Cod annually, in the summer. De Kay makes the following statement about the barracuda: "This is a very active and voracious little fish. A number of them were caught in the harbor of New York and placed in a vessel with several other species. In a few hours they had devoured them all, and then commenced devouring each other. It has not been very commonly observed, owing to the difficulty of capturing them; but I have reason to believe that they are not very rare." In Great Egg Harbor bay the young were found in abundance. The smallest example seen there by myself was $2\frac{3}{8}$ inches long. The species was unknown to the fishermen. In Great South bay a single example was captured at Oak island September 30.

This barracuda is not seen in our markets, but the adults of more southerly species are considered excellent food fishes. At Key West and on Cozumel island, and in the West Indies, the barracuda is highly prized.

Several young barracuda were caught in Gravesend bay in September 1896. The species is not common in that bay. An individual 5½ inches long was seined at Sandy Hook, Oct. 8, 1897. The fish does not live long in captivity.

Suborder RHEGNOPTERI

Family POLYNEMIDAE

Threadfins

Genus POLYDACTYLUS Lacépède

Anal fin not much longer than soft dorsal, of about 13 or 14 rays; vomer with teeth; preoperculum serrate; free filaments of pectorals mostly shorter than body; teeth in villiform bands on both jaws, vomer, palatines, and pterygoids; preopercle sharply serrated on its posterior margin, its angle with a scaly flap; scales rather small, finely ctenoid; first dorsal with seven or eight feeble, rather high spines, the first and last short, soft dorsal and anal fins about equaling each other; pectoral filaments three to nine; pyloric caeca in great number. Species numerous, in warm seas.

188 Polydactylus octonemus (Girard)

Threadfin

Polynemus octonemus GIRARD, Proc. Ac. Nat. Sci. Phila. 167, 1858, Brazos; Santiago; Galveston; young; GÜNTHER, Cat. Fish. Brit. Mus. II, 320, 1860; GOODE & BEAN, Proc. U. S. Nat. Mus. II, 128, 1880; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 413, 1883.

Polydactylus octonemus JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 830, 1896, pl. CXXVIII, fig. 350, 1900; BEAN, Bull. Am. Mus. Nat. Hist. IX, 358, 1897.

Trichidion octofilis GILL, Proc. Ac. Nat. Sci. Phila. 280, 1861, New York; adult.

Trichidion octonemus GILL, op. cit. 280, 1861.

Polynemus octofilis JORDAN & GILBERT, Proc. U. S. Nat. Mus. 590, 1882; Bull. 16, U. S. Nat. Mus. 413, 1883.

Body compressed, moderately elongate, its greatest depth from one third to two sevenths of the total length without caudal, its thickness equal to two fifths of length of head;

caudal peduncle short and stout, its least depth one half the length of head; head short, a little more than one fourth of total length without caudal, its width nearly one half its length; snout obtusely conical, its length varying with age from one seventh to one fifth of length of head; eye equal to interorbital space and its length contained from four and one third to five and one half times in length of head; mouth inferior, slightly oblique, wide, the lower jaw included, maxilla broadly expanded behind, its end reaching far behind eye, length of upper jaw nearly one half of length of head; hind margin of preopercle with numerous rather coarse spines. Distance of spinous dorsal from tip of snout equals one third of total length without caudal, base of spinous dorsal one half as long as the head, second spine longest one fifth of total without caudal, last dorsal spine two ninths as long as the second, interspace between dorsals equal to postorbital part of head, base of second dorsal contained one and three fourth times in length of head, longest dorsal ray equal to postorbital part of head, last dorsal ray one third as long as the head. Anal origin is under the fifth or sixth ray of the second dorsal, the base of the fin equals the second spine of the dorsal in length; the longest ray is one half as long as the head; the last ray is as long as the snout and eye combined. The ventral origin is under the middle of the spinous dorsal; the length of the fin is about one half the length of head. The pectoral reaches beyond the end of the spinous dorsal, but not to the vent, its length equal to length of head without the snout; the pectoral filaments are eight in number on each side, the longest reaching past the vent. Caudal deeply forked, its external rays longer than the head. D. VIII I, 12; A. III, 13; V. I, 5; P. I, 15, 8; B. VII. Gill rakers, 21 below the angle, the longest nearly equal to eye; scales 6–70–10. Color light olivaceous, with dark punctulations; belly whitish; pectoral black in adult, pale in young.

The threadfin is found on the east coast of the United States from New York to Texas, occurring northward in summer only.

Sep. 24, 1896, three specimens were obtained by John B. De

Nyse in Gravesend bay and sent to the aquarium dead, as they would not endure captivity. The fish agrees in coloration and in every other respect with P. octofilis Gill, and is believed to be the adult form of P. octonemus Girard. This is probably the first record of its occurrence in New York waters for more than 30 years.

MEASUREMENTS

	Inches
Length, including caudal	8¾
Length to end of middle caudal rays	7½
Length to origin of middle caudal rays	6⅝
Greatest depth of body	2
Least depth of caudal peduncle	15/16
Length of head	1⅜
Length of snout	5/16
Diameter of eye	5/16
Length of upper jaw	⅜
Length of mandible	¾
Length of longest pectoral filament	2⅜
Length of upper and lower caudal lobes	2¼
Length of pectoral	1½
Length of longest (third) dorsal spine	1¼
Length of second dorsal ray	1¼
Length of ventral	13/16
Length of longest anal ray	1
Length of anal base	1⅛
Length of base of first dorsal	¾
Length of base of second dorsal	1⅛

The longest pectoral filament reaches to below the interspace between the two dorsals and slightly past the vent. The diameter of the eye equals the length of the snout and one fifth the length of the head.

Group AMMODYTOIDEI

Family AMMODYTIDAE

Sand Lances

Genus AMMODYTES (Artedi) Linnaeus

Body elongate, lanceolate, the skin with many transverse folds running obliquely downward and backward, the small cycloid scales mostly placed in cross series between them; lateral line concurrent with the back; a fold of the skin along each side of the belly; vomer not armed with a bicuspid tooth; color silvery; vertebrae 62 or 63; one pyloric caecum. Carnivorous

fishes inhabiting sandy shores in cold regions, living in large schools, burying themselves in the sand near the tide mark. Valued as bait and useful as food for salmon and other larger fishes.

189 Ammodytes americanus De Kay

Sand Lance; Sand Eel

Ammodytes americanus De Kay, N. Y. Fauna, Fishes, 317, pl. 52, fig. 167, 1842, Queens County, New York, and Stratford, Conn.; Storer, Hist. Fish. Mass. 216, pl. XXXIII, fig. 2, 1867; Goode & Bean, Bull. Essex Inst. XI, 20, 1879; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 414, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 833, 1896, pl. CXXIX, fig. 351, 1900; Bean, Bull. Am. Mus. Nat. Hist. IX, 359, 1897.

Ammodytes vittatus De Kay, N. Y. Fauna, Fishes, 318, pl. 60, fig. 197, 1842, New York, apparently based upon a mutilated specimen, *fide* Jordan & Evermann.

Argyrotaenia vittata Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 415, 1883.

Body long, slender, subterete, its greatest depth one tenth to one twelfth of total length without caudal, its width two fifths of length of head; head moderately long, with acutely pointed snout, length of head one fifth of total without caudal; snout nearly one third as long as the head; eye small, one sixth as long as the head, and equal to width of interorbital space; lower jaw somewhat projecting, the mandible nearly one half as long as the head, the maxilla reaching back to front of orbit; dorsal origin in advance of tip of pectoral; length of pectoral about one half the length of head; length of anal base nearly one third of total without caudal; dorsal and anal rays about equal in length and not much longer than the eye; intermaxillary protractile; vomer not armed with a bicuspid toothlike prominence, D. 55 to 63; A. 27 to 31. Lateral folds 127 to 141.

The specimens examined are from 4½ to 7 inches long, from Nantucket, Woods Hole and Bass Rocks, Mass.

Colors as given by Dr Storer: of a dirty greenish brown on the back, the sides and abdomen silvery, the top of the head flesh-colored, the preopercles silvery, operculum cupreous and silvery, pupils black, iris silvery.

The sand lance occurs on sandy shores from Newfoundland to Cape Hatteras. In certain harbors of Cape Cod and Marthas Vineyard it often schools in myriads, so that the entire bottom

is covered from 1 to 2 inches deep and appears like an immense sheet of silver. These little fish are a very important source of food for the cod, salmon and other valuable fishes and are excellent for bait.

De Kay found the young frequently washed on shore after heavy northerly gales.

The sand lance appears in Gravesend bay in July, but is more plentiful in winter. The fish buries itself in sand and sometimes, when alarmed, will leap 4 inches above the sand. In captivity it swims continually and soon dies. It will not thrive for want of sand and proper food.

Group BERYCOIDEI

Family MULLIDAE

Surmullets

Genus MULLUS Linnaeus

Villiform teeth in the lower jaw and on the vomer and palatines, none in the upper jaw, the bone forming a hook over the maxillary well developed; opercle without spines; interorbital space flat and wide. Otherwise as in Upeneus, the head rather shorter. One species known.

190 Mullus auratus Jordan & Gilbert

Red Mullet; Goatfish

Mullus barbatus auratus JORDAN & GILBERT, Proc. U. S. Nat. Mus. 280, 1882. Pensacola, Florida; Bull. 16, U. S. Nat. Mus. 931, 1883.

Mullus auratus JORDAN, Proc. U. S. Nat. Mus. 39, 1884; BEAN, Bull. Am. Mus. Nat. Hist. IX, 359, 1897; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 856, 1896, pl. CXXXII, fig. 360, 1900.

Body moderately deep and compressed, its width equal to postorbital length of head, its greatest depth nearly equal to length of head and contained three and one half times in total length without caudal; least depth of caudal peduncle equal to postorbital part of head; head two sevenths of total length without caudal; anterior profile rather steep; intermaxilla protractile; mouth small, terminal, the upper jaw one third as long as the head and about equal to length of mandible; eye placed high, interorbital space nearly flat, its width greater

than long diameter of the eye, and about two sevenths of length of head, eye about three elevenths of length of head; barbels one fifth of total length to end of scales, and equal to length of pectoral. The spinous dorsal begins over the fifth scale of the lateral line, its base one half as long as the head, its longest spine two thirds as long as the head, its last spine scarcely as long as the eye, interspace between dorsals equal to one third the length of head, base of second dorsal one half as long as the head, longest ray slightly more than one half the length of head, last ray as long as the eye. The ventral origin is under the axil of the pectoral, also under the third scale of the lateral line; the length of the ventral is one fifth of total length to end of scales; the ventral fin reaches a little farther back than the pectoral, to a point below the twelfth scale of the lateral line. The anal origin is under about the third ray of second dorsal; the base is as long as postorbital part of head; the longest ray one half, and the last ray two sevenths of length of head. Caudal deeply forked, the middle rays, from end of scales, two fifths as long as the outer rays, which are three fourths as long as the head. Pectoral fin three fourths as long as the head, reaching to below the 12th scale of the lateral line, and end of spinous dorsal base. D. VII–I, 8; A. II, 6; V. I, 5; P. 16. Scales $34\frac{1}{2}$ 35–6.

Color scarlet; side with two yellow longitudinal stripes; snout and caudal fin scarlet, the latter with about five narrow dusky bands after preservation in spirits; first dorsal fin with an orange band at base and a yellow band higher up, the rest of the fin pale; second dorsal fin with about three narrow bands of scarlet; anal and ventrals pale; pectoral reddish; iris violet or golden; sides of head silvery, iridescent.

The red mullet ranges from Cape Cod to Florida; it is found at Woods Hole Mass., occasionally in summer; on the red snapper banks off Pensacola Fla. it is moderately abundant. The fish grows to the length of 8 inches. It has no economic value, but furnishes food for the red snapper, groupers and other food fishes.

Three individuals of Mullus were captured in a seine at Sandy Hook N. J. Oct. 8, 1897, and brought alive to the New York aquarium, where they are now (Nov. 30, 1897) in good condition and feed freely on shrimp. As the fish are living, it is uncertain whether or not they are M. auratus; but they agree in the main with the description of that species. Their endurance of water at a temperature of 50° F. is unexpected. Fishermen at Sandy Hook reported that large numbers were seen there in September and October 1897.

Recent examination of one of the specimens above referred to (No. 48796, U. S. National Museum) shows its entire agreement with the type of Mullus auratus.

Group SCOMBROIDEI

Family SCOMBRIDAE

Mackerels

Genus SCOMBER (Artedi) Linnaeus

Body fusiform, rather elongate, somewhat compressed; caudal peduncle slender, without median keel, but with two small keels on each side; mouth wide, with a single row of rather small, slender teeth in each jaw and on the vomer and palatines; maxillary slipping under the broad preorbital, a fleshy lobe on each side of lower jaw near its junction with maxillary; scales very small, not forming a corselet; first dorsal of nine to 12 feeble spines, separated from the second by an interspace greater than the base of the fin, second dorsal small, followed by five to nine detached finlets; anal similar to second dorsal, with similar finlets; pectorals and ventrals small, the former placed high, on the level of the eyes; caudal fin small, widely forked; pyloric appendages exceedingly numerous; air bladder small or wanting; vertebrae normally formed, 14+17 = 31; gill rakers long and slender.

Subgenus SCOMBER

191 Scomber scombrus Linnaeus

Common Mackerel

Scomber scombrus LINNAEUS, Syst. Nat. ed. X, 297, 1758, Atlantic; GOODE & BEAN, Bull. Essex Inst. XI, 14, 1879; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 424, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 865, 1896, pl. CXXXIII, fig. 363, 1900.

Scomber vernalis MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 423, 1815, Sandy Hook, New Jersey; DE KAY, name omitted from chapter heading, N. Y. Fauna, Fishes, 101, pl. 12, fig. 34, 1842, New York coast; STORER, Hist. Fish. Mass. 54, pl. XI, fig. 2, 1867.

Scomber scomber LINNAEUS, Syst. Nat. ed. XII, 492, 1766; GÜNTHER, Cat. Fish. Brit. Mus. II, 357, 1860.

Body moderately long, subterete, fusiform, the snout acute and the caudal peduncle much tapering posteriorly, the greatest hight two ninths of total length without the caudal, the least depth of caudal peduncle equal to the short diameter of the eye, the width of body one half the length of head; head conical, pointed, its length one fourth of total without caudal, its width one half its length, the width of the interorbital space one half postorbital length of head; snout rather long, one third as long as the head; lower jaw slightly projecting, the mandible extending behind orbit, its length more than one half the length of head, the maxilla reaching to below front of pupil. The eye is one fifth as long as the head. The spinous dorsal originates over the middle of the pectoral; its base is a little longer than the mandible; the second, and longest, spine is two fifths as long as the head; the last spine is very short, about one third of length of eye; the interspace between the dorsals is about equal to depth of body; the second dorsal base is nearly opposite anal base, slightly in advance, its length two fifths of length of the head; the longest ray is one fourth as long as the head, the last ray two thirds as long as the eye; the second dorsal is followed by five finlets, each as long as the last ray. The anal origin is under the fourth or fifth ray of the second dorsal; the base of the fin is one third as long as the head; the longest ray is one half of postorbital length of head; the last ray is two thirds as long as the eye; the fin is followed by five finlets which are immediately opposite the dorsal finlets and of about the same size. The middle caudal rays, from end of scales, are equal to one half the greatest depth of body; the external rays are nearly twice as long as the middle rays. The ventral origin is very slightly in advance of the origin of spinous dorsal, its distance from tip of snout equaling the distance from origin of second dorsal to root of caudal fin; the length of the ventral equals three

eighths of length of head. The pectoral is one half as long as the head; the fin reaches to below the sixth spine of the dorsal. No air bladder. D. XI–I, 11–V; A. I, 11–V; V. I, 5; P. I, 16.

Color dark blue, or greenish blue, above, the upper parts with 30 or more wavy transverse bands of a darker hue, these extending below the lateral line and nearly to the median line of the body; beneath the ends of these lines and slightly separated from them is a narrow, longitudinal, dark streak running almost the entire distance from the pectoral to the caudal; top of the head very dark; a dark blotch in the axil of the pectoral; gill covers and jaws silvery; sides white with cupreous reflections; belly white.

The mackerel is one of the best known food fishes of the north Atlantic, ranging from Norway to Spain in Europe and from Labrador to Cape Hatteras in North America. It reaches the length of 18 inches. The fish is migratory and frequently disappears for a short or long period of time from its accustomed localities. On the New York coast the mackerel appears in May and June in great schools, but the number varies greatly in different years.

Two young, 3¼ to 5½ inches long, were taken in Gravesend bay, L. I., May 23, 1896, in John B. De Nyse's shad fyke. No more were seen, and these were the first for the year. They come about the time of the appearance of anchovy and weakfish. They are often seen swimming at the surface of the bay in small bunches of 18 or 20, occasionally 100, in the latter part of May or early in June. They are always split up into small bunches, probably by the attacks of weakfish and other predaceous species which are present at the time. Flukes attack them also in shallow water.

Subgenus PNEUMATOPHORUS Jordan & Gilbert

192 Scomber colias Gmelin

Chub Mackerel; Thimbleeye Mackeral

Scomber colias Gmelin, L. Syst. Nat. 1329, 1788, Sardinia; De Kay, N. Y. Fauna, Fishes, 104, pl. 11, fig. 33, 1842; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 866, 1896, pl. CXXXIII, fig. 364, 1900; Bean, Bull. Am. Mus. Nat. Hist. IX, 360, 1897.

Scomber pneumatophorus DE LA ROCHE, Ann. Mus. Nat. Hist. XIII, 315, 334, 1809, Balearic Islands.

Scomber grex MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 422, 1815; STORER, Syn. Fish. N. A. 90, 1846.

Scomber dekayi STORER, Hist. Fish. Mass. 52, pl. XI, fig. 1, 1867; GOODE & BEAN, Bull. Essex Inst. XI, 15, 1879.

Body fusiform, subterete, moderately elongate, its greatest depth two ninths of total length to base of caudal fin; least depth of caudal peduncle two thirds of the short diameter of the eye, its width more than one half the length of head and equal to snout and eye combined; head conical, pointed, compressed, its length contained three and three fourths times in total to base of caudal, its width equal to one half its length, width of interorbital space three fifths of length of postorbital part of head; snout long, pointed, two sevenths as long as the head; lower jaw slightly projecting, the mandible extending to below hind edge of pupil, its length less than one half the length of head; the maxilla reaching nearly to front of pupil. The eye is large, covered in front and behind by an adipose membrane, its length three elevenths of length of head or two thirds of length of postorbital part of head. The spinous dorsal originates over the middle of the pectoral, a little behind the insertion of the ventral; the base is as long as the head without the snout and is much longer than the mandible; the second spine longest, one half as long as the head, the last spine minute, about one fifth as long as the eye. The interspace between the dorsals is only two thirds of depth of body. The second dorsal base is chiefly opposite anal base, but more in advance than in Scomber scombrus, its length equal to postorbital part of head; the longest ray is one fourth as long as the head, the last ray one half as long as the eye; the second dorsal is followed by five finlets, which increase in size posteriorly, the last one larger than last ray of dorsal, and two thirds as long as the eye. The anal origin is under the fifth or sixth ray of the second dorsal; the base of the fin is as long as the postorbital part of the head; the longest ray equals the longest of the dorsal; the last ray is one half as long as the eye; the fin is followed by five finlets of the same size as the dorsal finlets and

placed nearly opposite to them. The middle caudal rays are very short; the external rays are as long as the snout and eye combined. The ventral origin is equally distant from tip of snout and vent; the fin is two fifths as long as the head. The pectoral is one half as long as the head and reaches to below the fifth spine of the first dorsal. Air bladder present. D. IX to X–I, 11 to 12–V; A. I–I, 11–V or VI; V. I, 5; P. I, 19. Scales nearly 200.

Colors essentially the same as in Scomber scombrus, the wavy transverse bands about 30 in number; sides mottled with small dusky blotches below the median line; about 20 black specks on base of preopercle, usually arranged in more than one series; belly and sides silvery; a black blotch in axil of pectoral.

The chub mackerel is found in the Atlantic and Pacific oceans, north to England and Maine and to San Francisco; very common in the Mediterranean and in southern California; sometimes abundant on our eastern coast and frequently absent for long periods. It reaches the length of 14 inches and is an important food fish.

July 25, 1887, the schooner Peter Cooper caught 6000 thimbleeye mackerel off Manasquan N. J. About 50,000 mackerel were taken by the menhaden steamer, A. Morris, near Ocean City, July 19, 1887. Some of these were preserved in brine by W. B. Steelman, and I found them to be S. colias.

The thimbleeyes usually arrive in August. In 1886 they were often caught. This species was not found in large numbers in Gravesend bay in 1897, but in 1896 it abounded in all the little creeks, and in some instances the fish could be dipped up by the boat load with scoop nets. The fish reached 10 inches in length before the end of the summer.

Genus Auxis Cuvier

Body oblong, plump, mostly naked posteriorly, anteriorly covered with small scales, those of the pectoral region enlarged, forming a corselet; snout very short, conical, scarcely compressed; mouth rather small, the jaws equal; teeth very small, mostly in a single series, on the jaws only; tail very slender,

depressed, with a rather large keel on each side; first dorsal short, separated from the second by a considerable interspace, second dorsal and anal small, each with seven or eight finlets; pectorals and ventrals small; no air bladder; branchiostegals seven; pyloric caeca dendritical; gill rakers very long and slender, numerous; vertebrae 39 in number, peculiarly modified, essentially as in Gymnosarda.

193 Auxis thazard (Lacépède)

Frigate Mackerel

Scomber thazard Lacepede, Hist. Nat. Poiss. III, 9, 1802. Coast of New Guinea.

Auxis rulgaris Cuvier & Valenciennes, Hist. Nat. Poiss. VIII, 139, 1831, Mediterranean.

Auxis rochei Günther, Cat. Fish. Brit. Mus. II, 369, 1860; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 425, 1883.

Auxis thazard Jordan & Gilbert, op. cit. 911, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 867, 1896, pl. CXXXIII, fig. 365, 1900.

Body stout, subterete, fusiform, tapering to a very low caudal peduncle, the greatest depth one fourth of total length without caudal, the width nearly two thirds of the depth; the least depth of caudal peduncle about two fifths of length of iris; head short, conical, pointed, its length one fourth of the total to end of middle caudal rays, its width two thirds of its length, the width of the interorbital space one half postorbital length of head; snout short, as long as the eye, one fifth as long as the head; the lower jaw not projecting when the mouth is closed, the maxilla reaching to below middle of pupil, the mandible two fifths as long as the head and reaching nearly to below hind margin of orbit. The eye is as long as the snout and one fifth as long as the head. The spinous dorsal originates a little behind the origin of pectoral and ventral, at a distance from tip of snout nearly equal to one third of total length to caudal base; its base is nearly one half as long as the head; the second spine longest, two fifths as long as the head, the last spine minute, about one sixth as long as the eye. The interspace between the dorsals equals the length of the head without the snout. The second dorsal is in advance of the anal; its base is about one fourth as long as the head; its longest ray equals snout, and its last ray is less than

one half the snout; the fin is followed by eight finlets, which decrease in size posteriorly. The anal origin is below the interspace between the end of the second dorsal and its first finlet; the anal base is as long as the second dorsal base; its first ray is as long as the snout, its last ray is one half the short diameter of the eye; it is followed by seven finlets, decreasing in size posteriorly. The middle caudal rays, from end of keel, are one fourth as long as the outer rays, which are one half as long as the head; the caudal lobes form a very obtuse angle with the caudal peduncle. The ventral origin is directly under the root of the pectoral; the fin is as long as the snout and eye combined, the ventral sheath about as long as the fin. The pectoral is falcate, many-rayed, its length four ninths of length of head; the fin reaches to below the last spine of the first dorsal. D. X–12–VIII; A. 13–VII; V. I, 5; P. 22; B. VII.

Color dark blue above with reticulated markings on the back, chiefly in the second half of the length and all above the lateral line; sides, lower parts and head silvery; ventral dark.

The frigate mackerel is found in all warm seas and ranges northward occasionally to Cape Cod; it is a rare visitor in our waters, but sometimes appears in immense schools. It has little value as food. It reaches the length of 16 inches. The species was unknown on our shores till 1880, when it arrived in almost countless numbers. Its food is the same as that of the common mackerel.

Genus GYMNOSARDA Gill

This genus according to Lütken differs from Thunnus 1) in the absence of teeth on vomer; 2) by the complete absence of scales outside of the corselet (for in Thunnus of the same size the skin is covered with small scales; and the limits of the corselet in the tunny and albicore are obscure, so that it can not properly be said that they have distinct corselets), and 3) by an important osteologic character, namely the peculiar development, in the form of a network or trellis, of a portion of the abdominal part of the backbone, between the vertebrae proper and the hemapophyses. Vertebrae 38. Species of smaller size than the tunnies, also pelagic, and of little value as food.

194 Gymnosarda pelamys (Linnaeus)

Oceanic Bonito

Scomber pelamis LINNAEUS, Syst. Nat. ed. X, I, 297, 1758, tropical seas.
Thynnus pelamys CUVIER & VALENCIENNES, Hist. Nat. Poiss. VIII, 113, 1831.
Orcynus pelamys POEY, Syn. Pisc. Cubens. 362, 1868; GOODE & BEAN, Proc. U. S. Nat. Mus. I, 24, 1878; Bull. Essex Inst. XI, 15, 1879.
Euthynnus pelamys JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 430, 1883.
Gymnosarda pelamis DRESSLAR & FESLER, Bull. U. S. F. C. VII, 436, 1889; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 868, 1896.

Body oblong, abruptly tapering at both ends, stout, short, its greatest hight one fourth of total length to end of middle caudal rays, its width a little more than one half the length of head, equal to postorbital part of head; least hight of caudal peduncle one half the length of eye; keel one fourth as long as the head; head rather long, somewhat compressed, acute in front, conical, its length two sevenths of the total without caudal, its width over the opercles one half its length; snout not long, acute at tip, somewhat compressed, its length two sevenths of length of head; the mandible heavy and prominent, scarcely projecting; the maxilla with rounded extremity extends to below middle of pupil; the mandible extends to below hind margin of eye, its length nearly one half the length of head. The eye is obliquely oblong, its length about one fifth of length of head. The spinous dorsal orginates immediately over the origins of the pectoral and ventral; the base of the fin is four fifths as long as the head; the first and longest spine one half as long as the head, the last spine one fourth as long as the snout. The interspace between the dorsals equals two thirds of length of snout. The second dorsal is equidistant from the upper angle of the gill opening and the base of the caudal fin; the base of the fin is as long as the snout and equal to base of anal; the longest ray is a very little longer than the base of the fin, the last ray is one fourth as long as the snout; the fin is followed by eight finlets, the largest in front, two fifths as long as the snout. The middle caudal rays, measured from keel, one third as long as the outer rays, which are nearly two thirds as long as the head (equal to postorbital part of head). The anal origin is nearly under the end of the second dorsal; the base of the fin is two sevenths as long as the

head; the longest ray is as long as the base of the fin, the last ray one third of length of snout; the fin is followed by seven finlets, which are rather broader than those of the dorsal. The ventral origin is directly under the origin of spinous dorsal; the length of the fin is two fifths of length of head; the ventral sheath is bifurcate and less than one half as long as the fin. The pectoral is scarcely falcate, its length one half the length of head, the fin reaching to below the 11th spine of the dorsal. D. XIV to XV, II, 12–VIII; A. II, 12–VII; P. 28; V. I, 5.

The corselet is very prominent. Its contour is defined by lines at the edge of the branchial cleft, about midway between the axil of the pectoral and the median line of the belly, extending below, beyond, and around the extremity of the pectoral (which, when normally placed, touches with its tip the outer margin of the corselet), then extending beyond its tip for a distance nearly equal to its length, around up into the lateral line, down which a narrow tract of scales continues to its extremity, though narrowed to a single row after passing its curve; passing the lateral line, the contour of the corselet curves forward and inward, then, ascending to a point distant from the median line of the back about the diameter of the orbit, it follows backward in a direction parallel to this line, to a point opposite the posterior extremity of the second dorsal, where it curves upward to the median line of the body, and completes its circuit.

When viewed from above, the rows of scales appear to be arranged concentrically about the origin of the first dorsal fin. The scales are largest along the edges of the pectoral arch and the dorsal fin, decreasing rapidly in size as they recede from these regions. There are about 30 rows between the dorsal and the upper margin of the pectoral, normally placed.

The upper parts deep bluish in life; the belly and flanks below lateral line, the opercles and throat pearly opalescent white; the lower part of the pectoral arch and tracts at the base of the ventrals and anal, as well as those parts of the opercles where the bone is close to the outer skin, chalky white. The corselet is bronzed brown in the alcoholic specimen. There are four dis-

tinct bluish lines on the sides, which are nearly parallel with the lateral line, and constitute the most prominent specific character. The first of these begins directly under the tip of the pectoral, the second at the margin of the corselet, at a point in the line from the upper to the lower axillary angles of the pectoral. The third and fourth are rather indistinct anteriorly, but very distinct in the posterior half of the body, and are about as far distant from each other as are the first two, the interval between the two pairs being slightly greater than that between the members of each pair, and equal to the diameter of the orbit. The first or uppermost line is nearly straight, the others, following the lower contour of the body, curve upward over the anal fin, and all four become lost in the darker color of the caudal peduncle.

If the Japanese fish, which has been referred to this species, be really the oceanic bonito, we must add the following notes on colors: three shorter dark stripes on the middle of the body, between the lateral line and the uppermost of the four long stripes; dark blotches on the membrane connecting the dorsal spines, beginning between the sixth and seventh spines and continuing to the end of the fin. It is not at all certain, in my estimation, that the Japanese form is the same as ours, since it appears to have a more compressed body, the spinous dorsal more posteriorly placed, and the color differences above mentioned.

The oceanic bonito is said to inhabit the warmer parts of the Atlantic and Indian oceans and the seas of China and Japan. It is a rare visitor in our waters and has no importance for food. Persons who have eaten it say the flesh is dry and, sometimes, disagreeable. It feeds on flying fish, skipjacks, small cuttlefish, mollusks, and marine plants. The maximum length recorded is 30 inches.

195 Gymnosarda alleterata (Rafinesque)

Little Tunny

Scomber alleteratus Rafinesque, Caratteri Alc. Gen. 46, 1810, Palermo.
Thynnus thunnina Cuvier & Valenciennes, Hist. Nat. Poiss. VIII. 104, 1831, Mediterranean; Günther, Cat. Fish. Brit. Mus. II, 364, 1860.
Thynnus brasiliensis Cuvier & Valenciennes, op. cit. 110, Mediterranean.
Thynnus brevipinnis Cuvier & Valenciennes, op. cit. 112, Mediterranean.

Orcynus alliteratus GILL, Rept. U. S. Fish. Comm. 802, 1873; GOODE & BEAN, Bull. Essex Inst. XI, 15, 1879.
Euthynnus alliteratus JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 430, 1883.
Thynnus affinis GÜNTHER, op. cit. II, 363, 1860.
Thynnus brevirostris GÜNTHER, op. cit. II, 365, 1860.
Gymnosarda alleterata JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 869, 1896, pl. CXXXIV, fig. 366, 1900.

Body fusiform, much tapered at both ends, moderately compressed, its greatest hight one fourth of total length without caudal, its width one half the length of the head; least depth of caudal peduncle one third of length of snout; keel well developed, three eighths as long as the head; head moderate, pointed in front, its length one fourth of the total to end of middle caudal rays, its width over the opercles equal to eye and snout combined; snout not long, acute at tip, its length two sevenths of length of head; the interorbital space equal to snout; the mandible heavy, not projecting, the maxilla expanded posteriorly, extending to below middle of pupil; the mandible extends to below hind margin of orbit, its length nearly one half the length of head. The eye is one fifth as long as the head, and two thirds of width of interorbital space. The spinous dorsal originates directly above the insertion of the ventral and slightly behind that of the pectoral; the base of the fin is nearly as long as the head; the longest spine is one half as long as the head, the last spine about one half as long as the eye; the interspace between the dorsals extremely short. The second dorsal is preceded by a short, stiff spine, which is about one third as long as the eye; the base of second dorsal is one fourth as long as the head; the longest ray is two ninths as long as the head, the last ray one half as long as the eye; the fin is followed by eight finlets, of which the fourth is longest, two thirds as long as the eye. The middle caudal rays, measured from the root of the fin, are two fifths as long as the outer rays, which are two thirds as long as the head. The anal origin is under the first detached finlet; the base of the fin is as long as the snout; the longest ray two ninths as long as the head, the last ray two thirds as long as the eye; the fin is followed by seven finlets, which are similar to the dorsal finlets. The

ventral origin is at a distance from tip of snout equal to one third of total length to caudal base; the fin is two fifths as long as the head, extending as far back as the pectoral, to a point below the ninth spine of the dorsal. The ventral sheath is little bifurcate at its tip, its length little more than one half the length of ventral fin. The pectoral is somewhat falcate, its length equal to postorbital part of head. D. XV–I, 12–VIII; A. ii, 12 VII; V. I, 5; P. I, 26.

Color bluish above, sides and lower parts silvery; several wavy, more or less interrupted, dark streaks above lateral line, beginning under the middle of the spinous dorsal; five or six roundish brown spots, about as large as the pupil, between the pectoral and ventral fins; tip of spinous dorsal and inner surface of ventral dusky.

The little tunny is common in the Mediterranean and the West Indies and ranges northward occasionally to Cape Cod. It is said to reach the length of 4 feet, but no individuals of that size are recorded from our waters. Prof. S. F. Baird collected an example about 2 feet long at Woods Hole Mass. in 1871. A specimen 13 inches long was taken at Pensacola Fla. by Silas Stearns in 1878. Though eaten in Mediterranean countries, the flesh is not much esteemed.

Genus THUNNUS South

Body oblong, robust, with very slender caudal peduncle; head conical; mouth wide, with one series of small, conical teeth in the jaws and bands of minute villiform or sandlike teeth on the vomer and palatines; scales present, those of the pectoral region forming an obscure corselet; first dorsal of 12 to 15 spines, which grow gradually shorter backward, the interval between last spine and second dorsal slight; second dorsal and anal short and rather high, each with eight to 10 finlets; ventrals moderate, pectorals moderate, inserted rather below the level of the eye; vertebrae normal, 39 to 41 in number, the lower foramina very small. Open seas; the single species widely distributed. Size very large.

196 Thunnus thynnus (Linnaeus)

Tunny; Horse Mackerel

Scomber thynnus Linnaeus, Syst. Nat. ed. X, 297, 1758. Europe.

Thynnus vulgaris Cuvier & Valenciennes, Hist. Nat. Poiss. VIII, 58, pl. 210, 1831, European Seas; De Kay, N. Y. Fauna, Fishes, 105, pl. 10, fig. 28, 1842, after Storer.

Thynnus brachypterus Cuvier & Valenciennes, op. cit. 98, pl. 211, 1831, Mediterranean.

Thynnus secundidorsalis Storer, Hist. Fish. Mass. 65, pl. XII, fig. 4, 1867.

Orcynus thynnus Goode & Bean, Bull. Essex Inst. XI, 15, 1879; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 429, 1883.

Thunnus thynnus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 870, 1896.

Body oblong, tapering greatly at both ends, very robust, its greatest depth nearly one fourth of the total length to end of middle caudal rays, its greatest width one sixth of the same length. The least depth of caudal peduncle equals the length of the eye. The head is two sevenths of total length without the caudal; the snout is rather short, acute, its length contained three and one third times in length of head; the maxilla does not quite reach to below front of eye; eye small, two fifths as long as the snout, one seventh as long as the head. The spinous dorsal originates above the insertion of the pectoral; the fin is very long, reaching almost to second dorsal, high in front and rapidly and regularly diminishing in hight posteriorly, its first spine longest, four ninths as long as the head, the last spine about as long as the pupil. The second dorsal base is as long as the anal base and two fifths as long as the head; the fin is deeply concave and very low behind, its longest ray one half as long as the head; the fin is followed by nine finlets which are about two thirds as long as the eye. The anal origin is under the end of the second dorsal; the base of the fin is two fifths as long as the head; the longest ray is nearly one half as long as the head; the fin is deeply concave like the second dorsal, and is followed by eight finlets of about the same size as the dorsal finlets. The caudal fin is very deeply forked, almost lunate in shape, the middle rays, measured from caudal base, contained two and one third times in the outer; the caudal keel is enormously developed, its length equal to length of snout. The ventral origin is under the second spine of the dorsal; the fin is

one half as long as the head; when extended it reaches to below the 11th spine of the dorsal. The pectoral reaches to below the 12th spine; it is falcate, its length equal to length of head without the snout. The corselet is not so well defined as in some other related species, because the entire body is scaly. The lateral line curves downward from a point under the origin of the second dorsal. D. XIV, i, 13–IX; A. i, 12–VIII; V. I, 5.

Color dark blue above; grayish below with silvery spots; pupil black, iris golden with greenish reflections; rays of spinous dorsal dusky, the connecting membrane nearly black, second dorsal reddish brown; pectorals silvery gray; ventrals black above, white beneath; dorsal and anal finlets bright yellow, dark at base and on anterior edge; gill covers silvery gray.

The tunny is the largest fish of the mackerel family, reaching a length of 10 feet or more. It is pelagic, but comes to all warm coasts, northward to England, Newfoundland, San Francisco, and Japan. In our waters it appears usually in summer and is often taken in rather large numbers off Block Island, and on Cape Cod and Cape Ann. On account of its enormous size and great strength, it is often destructive to the fishermen's fixed nets.

Dr Storer says it comes into Massachusetts bay about the middle of June and remains till early in October. It was not uncommon to observe 50 or more in a day at Provincetown. It feeds on menhaden, mackerel, whiting, dogfish and other small fishes. The usual implement of capture at first was the harpoon, but, now that its flesh has become valuable for canning and when marketed fresh, it is taken in pound nets and by line fishing. The fish arrives on the coast in poor condition and without value; but becomes very fat during the summer months, and is then utilized for the oil, which is obtained from the head and belly by boiling, and for its flesh, which is favorably regarded, either fresh, salted or preserved in cans.

The tunny is said to spawn in June, and the recently hatched young, according to Yarrell, weigh 1½ ounces, growing to 4 ounces by August and 30 ounces in October. Adults often

weigh 1000 pounds. The killer whale is the most dreaded enemy of the tunny.

In southern California this fish is highly prized by anglers who are fond of big game and hard play. In the Bay of Chaleur and off Caraquette, in the Gulf of St Lawrence region, 100 tunny were captured by means of baited lines, and the fishing was considered exciting because the fish pulled with such violence as to endanger the lives of the fishermen by dragging them overboard. This kind of exercise might be had near Rockport Mass. or off the New Jersey coast annually in summer.

Genus SARDA Cuvier

Body rather elongate, covered with small scales, those of the pectoral region forming a corselet; caudal peduncle slender, strongly keeled; head large, pointed, compressed; mouth large; teeth in the jaws rather strong, conical, slightly compressed, similar teeth on the palatines, but none on the vomer; maxillary not concealed by preorbital; gill rakers long and strong; first dorsal long and rather low, of 18 to 22 rather stout spines, which are gradually shortened behind; interval between the last spine and the second dorsal short; second dorsal small, followed by 8-9 finlets; anal fin similar, usually with one less finlet; paired fins small; pectorals placed below the level of the pupil; no air bladder; pyloric caeca very numerous, treelike; vertebrae normally formed, 50 to 54 in number. Fishes of rather large size, of metallic coloration. (After Jordan and Evermann)

197 Sarda sarda (Bloch)

Bonito

Scomber sarda BLOCH, Ichth. X, 35, pl. 334, 1793, Europe.

Pelamys sarda DE KAY, N. Y. Fauna. Fishes, 106, pl. 9, fig. 27, 1842; GÜNTHER, Cat. Fish. Brit. Mus. II. 367, 1860; STORER, Hist. Fish. Mass. 63, pl. XI, fig. 5, 1867.

Sarda pelamys GOODE & BEAN, Bull. Essex Inst. XI, 15, 1879.

Sarda mediterranea JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 427, 1883.

Sarda sarda BEAN, Bull. U. S. F. C. VII, 138, 1888; DRESSLAR & FESLER, Bull. U. S. F. C. VII, 440, pl. VIII, 1889; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 872, 1896; BEAN, Bull. Am. Mus. Nat. Hist. IX, 360, 1897, Gravesend Bay.

Body fusiform, much tapered at both ends, moderately elongate, robust, its greatest hight nearly equal to length of head and nearly one fourth of total length without caudal, its greatest width two thirds of its hight; least depth of caudal peduncle one third of length of snout; head four fifteenths to one fourth of total length to caudal base, its width over the opercles equal to length of its postorbital part; interorbital space strongly convex, one third of length of head, greater than snout, twice diameter of orbit; snout rather long, one third as long as the head, acute, the jaws equal in front; maxilla much expanded behind, reaching slightly behind orbit, the upper jaw one half the length of head; mandible equal to width of body, reaching considerably behind eye; eye small, vertically oblong, its vertical diameter about one half the length of snout. The spinous dorsal begins directly over the insertion of pectoral; the fin is very long, high in front, tapering rapidly and almost regularly to the last spine, which is only about one sixth as long as the second, and longest, this being two fifths as long as the head. The interspace between the dorsals is one half as long as the eye. The second dorsal base is as long as the snout and eye combined; the longest ray is four times as long as the last ray and one third as long as the head; the upper margin of the fin is deeply concave; the fin is followed by eight small finlets, the longest as long as the eye. The anal origin is under the last dorsal ray or the first dorsal finlet; the base of the fin is as long as the snout; the longest ray is nearly five times as long as the last ray and three eighths as long as the head; the fin is followed by seven or eight finlets (usually seven) the longest equal to length of eye; the anal is deeply concave, like the second dorsal. The caudal fin is crescentic, the external rays three times as long as the middle rays and the lobes narrow and tapering, their width at base about one third of their length and one fourth the length of head. The ventral origin is under the second or third spine of the dorsal; the fin is three tenths as long as the head; its sheath is small and raylike, less than one half as long as the fin. The pectoral is falcate, broad at base, short, reaching to

below the eleventh spine of the dorsal, its length one half the length of head. The lateral line very wavy but with no great curves; the caudal keel nearly as long as the eye and snout combined. The corselet is developed only as a narrow stripe extending from the nape to a point a little behind the tip of pectoral, its width about one fifth of its length, and about equal to eye. D. XX to XXI, 13 to 14–VIII; A. 14–VI or VII; V. I, 5; P. I, 24.

Color steel blue above, the sides silvery, the abdomen and under surface of head silvery white; from 19 to 20 dark bluish, narrow bands obliquely downward and forward from the back, some of them almost reaching the belly; iris yellowish; first dorsal fin sometimes pale, sometimes nearly black; pectoral dark above, light beneath.

The bonito inhabits the Atlantic ocean on both coasts and is common in the Mediterranean. On our coast it ranges habitually north to Cape Ann. It reaches the length of 30 inches and the weight of 10 or 12 pounds. Though not generally esteemed as a food fish, it meets with a steady sale either fresh or salted, like the mackerel. The fish is believed to live in the open sea, coming to the shores only to feed or to deposit its eggs. It is predaceous and active, feeding insatiably on mackerel and menhaden; it takes trolling bait as freely as the bluefish, to which it is not inferior in quality of flesh.

The fish is generally scarce in Gravesend bay. Five were taken in one day in a pound net in October 1897, an unusual number for that species. The bonito will not live in captivity.

Genus SCOMBEROMORUS Lacépède

Body elongate, wholly covered with rudimentary scales, which do not form a distinct corselet; head pointed, comparatively short and small; mouth wide, the strong teeth in the jaws more or less compressed or knife-shaped; villiform or sandlike teeth on the vomer and palatines; maxillary not concealed by preorbital; gill rakers few; caudal peduncle with a single keel; spinous dorsal low, of 14 to 18 feeble spines; soft dorsal and anal short, similar, somewhat elevated and falcate, each followed by

seven to 10 finlets; ventrals small; pectorals moderate, near the level of the eye; air bladder present; vertebrae normally formed, 45 in number. Fishes of the high seas; graceful in form and beautiful in color; among the best of food fishes. (After Jordan and Evermann)

198 Scomberomorus maculatus (Mitchill)

Spanish Mackerel

Scomber maculatus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I. 426, pl. VI, fig. 8, 1815, New York.

Cybium maculatum De Kay, N. Y. Fauna, Fishes, 108, pl. 73, fig. 232, 1842, New York; Günther, Cat. Fish. Brit. Mus. II, 372, 1860; Storer, Hist. Fish. Mass. 68, pl. XIII, fig. 1, 1867; Goode & Bean, Bull. Essex Inst. XI, 15, 1879.

Scomberomorus maculatus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 426, 1883; Bean, Bull. U. S. F. C. VII, 138, 1888; 19th Rep. Comm. Fish. N. Y. 254, pl. VII, fig. 9, 1890; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 874, 1896, pl. CXXXIV, fig. 368, 1900.

Body elongate, much compressed, fusiform, its greatest depth from one fourth to two ninths of total length without caudal, its width two fifths of its depth and equal to postorbital part of head; least depth of caudal peduncle one half the postorbital part of head; head rather short, compressed, the lower jaw heavy, but not projecting, length of head one fifth of total without caudal; maxilla somewhat expanded posteriorly, extending to hind margin of orbit, the upper jaw equal to snout and eye combined; 16 strong conical teeth on each side in upper jaw, and 13 in the lower, vomer with a broad, short patch of minute, villiform teeth, palatine teeth similar, in club-shaped patches; mandible equal to head without snout; snout one third as long as head, very acute; posterior nostril twice as large as anterior; eye one fifth as long as head; interorbital space very convex, its width nearly equal to snout; gill rakers short, 2 above and 11 below the angle of the first arch. The spinous dorsal originates over the insertion of the pectoral and considerably in advance of the ventral origin; the base of the fin is long, as long as the head plus the length of the snout; the second and longest spine is three sevenths as long as the head and four times as long as the last spine, the fin decreasing in hight regularly from

the second to the last spine. The interspace between the dorsals is about one half the length of the eye. The second dorsal base is three fourths as long as the head; the longest ray nearly four times as long as the last ray, and one half as long as the head; the fin is followed by eight finlets, none of which are longer than the eye. The anal originates under the middle of the soft dorsal; its base is two thirds as long as the head, its longest ray three and one half times as long as its last ray, and one half as long as the head; the fin, like the second dorsal, is deeply concave; it is followed by eight finlets equal in size to the dorsal finlets. The caudal is very deeply forked, its outer rays as long as the head. The ventral originates under the fourth spine of the dorsal, its length three elevenths of length of head, the fin reaching to below the ninth spine of dorsal; there is no ventral covering, the inner rays of the two sides being slightly united at the base. The pectoral is broad, falcate, extending to below the 10th dorsal spine, its length equal to head without snout. D. XVII to XVIII 16 to 18-VIII to IX; A. ii, 16 to 17; V. I, 5; P. i, 21. Lateral line strongly developed, with a moderate curve under the second dorsal, its course from there to caudal somewhat wavy.

Color silvery; upper parts bluish; sides with numerous oblong spots of a dull orange, none of them more than one third as long as the snout, these spots fully as numerous above the lateral line as below it; the membrane connecting the first eight spines of the dorsal black, the rest of the fin white; soft dorsal with a yellowish tinge, its margin dark; anal and ventral white; pectoral black inside, yellowish with dark borders outside and covered with dusky points; caudal dusky except at base.

The Spanish mackerel inhabits the Atlantic and Pacific coasts of North America, on our coast ranging north to Maine and south to Brazil. It is one of the choicest of our food fishes and grows to the length of 3 feet and the weight of 10 pounds. The species spawns on the Long Island coast in August or earlier. The eggs are very small, about $\frac{1}{25}$ inch in diameter, and they float in salt water. The rate of growth is unknown, as the

young are seldom or never seen by persons who know the fish. The Spanish mackerel is caught chiefly in pound nets.

It is recorded that the species has been obtained off the coast of Maine by Capt. Atwood. Mitchill describes the species without making any remark on its abundance or scarcity, and states that it comes in July. In 1854 the species had very little importance in the New York market, but at the present time it is one of the most highly prized fishes and is obtained in large numbers. Spanish mackerel have been sparingly caught by trolling off Fire Island inlet. We did not obtain the species in Great South bay, but Erastus Gordon of Patchogue informed us that it is obtained in moderate numbers. In 1884 the fish was not plentiful and the average price was about $1 each. They appear in New York waters in July and usually leave in September. The spawning season at Long Island begins late in August and continues about a month. The Spanish mackerel congregate in enormous schools. Mr Earll records the appearance of a school off Long Island which was estimated to contain several million individuals. The fish are taken principally in traps; a few are caught by trolling, but this is an unsatisfactory method of capture.

199 Scomberomorus regalis (Bloch)

Cero

Scomber regalis Bloch, Ichth. pl. 333, 1795, Martinique.
Cybium regale Gunther, Cat. Fish. Brit. Mus. II, 372, 1860.
Scomberomorus regalis Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 426, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 875, 1896, pl. CXXXV, fig. 369, 1900.

Very similar in shape and general appearance to S. maculatus: the greatest depth of body one fifth of total length without caudal, the greatest width two fifths of length of head; the least depth of caudal peduncle one half the length of snout; head longer than in S. maculatus, two ninths of total without caudal; the snout long and very acute, three eighths as long as the head; the interorbital space scarcely convex, its width two sevenths of length of head; jaws equal in

front, maxilla not reaching to hind margin of orbit, the upper jaw equal to snout and eye combined and much more than one half the length of head; the mandible equal to head without snout, reaching to below hind margin of orbit; 15 or 16 large, compressed, conical teeth in each side of upper jaw, and about the same number of similar teeth in lower; eye large, more than one fifth of length of head, nearly equal to interorbital space; gill rakers 3+12, the longest one half as long as the eye. The spinous dorsal originates a little farther back than the pectoral and nearly over the insertion of the ventral; the base of the fin equals its distance from tip of snout; the second spine is the longest, one half as long as snout and eye combined; the fin is shaped as in S. maculatus, the last spine being very short. The interspace between the dorsals is about one third the diameter of the eye. The second dorsal base is one half as long as the head and equal to its longest ray; the last ray is one half as long as the eye; the fin is followed by eight or nine finlets; its upper margin, like that of the anal, is deeply convex. The anal origin is under the middle of the second dorsal; the longest ray a little exceeds longest of dorsal; the last ray one half the length of eye; the fin is followed by eight finlets. The caudal keel is one third as long as the head; the caudal fin is very deeply forked, the outer rays as long as the head and the lobes narrow at the base. The ventral origin is midway between tip of snout and vent; the fin is two thirds as long as the snout and extends to below the seventh spine of the dorsal. The pectoral is broad at the base, falcate, its length equal to snout and eye combined, the fin extending to below the 10th spine of the dorsal. D. XVII–i, 15–VIII; A. ii, 14–VIII; V. I. 5; P. i, 24. Lateral line curved downward below the second dorsal and the second half of it more or less undulating; pectoral scaly.

Color silvery; a narrow longitudinal stripe of brownish or bronze beginning behind the pectoral and running to base of caudal; numerous oblong brownish spots mostly below this stripe, none of them more than one half the diameter of eye;

upper anterior part of spinous dorsal black, the rest of the fin white.

The spotted cero is found from Cape Cod to Brazil, but is not common northward; it is abundant in the West Indies. The species grows to the length of 5 feet and the weight of 20 pounds; it is a fish of the same good qualities as the Spanish mackerel and is readily caught by trolling.

200 Scomberomorus cavalla (Cuvier)

Kingfish; Sierra

Cybium cavalla Cuvier, Règne Anim., ed. 2, II, 200, 1829, Brazil.

Cybium caballa Cuvier & Valenciennes, Hist. Nat. Poiss. VIII, 187, 1831, Caribbean Sea; Storer, Syn. Fish. N. A. 93, 1846; Günther, Cat. Fish. Brit. Mus. II, 373, 1860.

Scomberomorus caballa Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 427, 1883.

Scomberomorus cavalla Goode & Bean, Bull. U. S. F. C. VII, 444, pl. XI, 1889; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 875, 1896.

Body more slender and elongate than in the other species of the genus, its greatest depth one sixth to one fifth of total length without caudal; rather less compressed than in *S. regale*; the least depth of caudal peduncle one half the length of snout; head one fifth of total length without caudal; snout acute, two fifths as long as head; maxilla long, reaching beyond hind margin of orbit; mandible a little longer than snout and eye combined; eye small, one sixth of length of head, the interorbital space convex; teeth triangular, much compressed, about 25 to 30 in each side of each jaw; gill rakers very short, eight below the angle on first arch. The spinous dorsal is inserted directly above the origin of the pectoral and slightly behind the ventral; its base equals one half the distance from tip of snout to origin of second dorsal; the second, and longest, spine is three times as long as the last spine and two sevenths as long as the head. The interspace between the two dorsals equals diameter of eye. The second dorsal originates midway between tip of snout and end of middle caudal rays; the base is as long as the snout and eye combined and is about equal to anal base; the longest ray is six times the length of last ray and equal to snout; the upper margin of the fin is deeply concave; the fin is

followed by nine small finlets, all nearly equal in size, about two thirds as long as the eye. The caudal fin is crescentic, the width of the lobe at base two fifths of its length, the external rays two and one half times as long as the middle rays, measured from root of fin, and one third of distance from tip of snout to origin of second dorsal. The anal origin is under the middle of the second dorsal; the longest anal ray is four times length of last ray and equal to snout; the upper margin is deeply concave; the fin is followed by eight finlets, the longest about one half the diameter of eye. The ventral is a little in advance of pectoral; its length one half the length of mandible, the fin reaching to below the sixth spine of dorsal. The pectoral is falcate, median, its length equal to snout and eye combined, and reaches to below the ninth spine of dorsal. A patch of elongate scales on head behind and below the eye and at the upper angle of the gill opening; several much enlarged scales behind the head, in front of and above the base of pectoral. The lateral line makes a deep downward curve under the end of the spinous dorsal, and its second half is sinuous. A well developed caudal keel. D. XIV to XV, i, 15–VIII to IX; A. ii, 15–VIII; V. I, 5; P. i, 23.

Color grayish silvery, the sides sometimes with dark spots, or yellowish in the young; spinous dorsal blackish above, or without dark blotch.

The kingfish, or cavalla, is a very important and valuable food fish of the tropical Atlantic, coming in immense numbers to the Florida Keys, the West Indies, and north to Charleston, occasionally, in summer, to Cape Cod. Southward it extends to Africa and Brazil, frequenting the open seas. It grows to the length of 6 feet and the weight of 100 pounds. In habits it resembles the Spanish mackerel; it is caught by trolling, and at Key West it is so abundant that two men in a small sailboat sometimes catch more than 100 in a day. The flesh is excellent, either fresh or smoked.

Family TRICHIURIDAE

Cutlas Fishes

Genus TRICHIURUS Linnaeus

Body extremely elongate, bandlike, the tail very slender tapering to a fine point, without caudal fin; head long, with a very wide mouth; the jaws armed with unequal and very strong teeth; upper jaw with about four long, strongly compressed barbed teeth; teeth on the palatines, none on the vomer; lower jaw longest; preorbital covering cleft of mouth posteriorly; dorsal fin single, low, occupying the whole of the back, the spines not distinguishable from the soft rays; anal very long, its base more than half the length of the body, composed of detached spines which are very short, nearly hidden in the skin, the anterior directed backward, the posterior forward; ventral fins wanting; pectorals small; no scales; lateral line decurved, concurrent with the belly; vertebrae 39 120, ribs excessively frail. Color silvery. Voracious fishes of the high seas, reaching a considerable size. (After Jordan and Evermann)

201 Trichiurus lepturus Linnaeus

Scabbard Fish; Hairtail

Trichiurus lepturus LINNAEUS, Syst. Nat. ed. X, I, 246, 1758, America; CUVIER & VALENCIENNES, Hist. Nat. Poiss. VIII, 237, 1831; DE KAY, N. Y. Fauna, Fishes, 109, pl. 12, fig. 35, 1842, Jamaica, Sandy Hook; GUNTHER, Cat. Fish. Brit. Mus. II, 346, 1860; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 422, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 889, 1896, pl. CXXXVII, fig. 375, 1900; BEAN, Bull. Am. Mus. Nat. Hist. IX, 360, 1897.

Trichiurus argenteus SHAW, Gen. Zool. IV, 90, pl. 12, 1803, after LINNAEUS; MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 364, 1815.

Body greatly compressed, elongate, tapering to a very fine point, the greatest hight little more than one half of length of head, which is contained from seven and one half to eight and one half times in total; mouth wide, oblique; the lower jaw strongly projecting, the maxilla mostly concealed under the preorbital, reaching to below front of pupil, the mandible one half as long as the head and extending to a point behind the orbit; interorbital space flat, its width equal to diameter of eye; snout long and acute, three tenths as long as the head; a single large

nasal opening near the front of the orbit; eye round, one sixth as long as the head; gill rakers spiny, few, about seven above the angle of the first arch, those below the arch mostly small or obsolete, the longest above angle about one third of diameter of eye; operculum produced into a long, thin flap, acute behind. The dorsal fin begins at a distance from tip of snout equal to two thirds of length of head; its origin is not far behind the eye; the longest ray is about three eighths as long as the head. The pectoral is partly covered by the opercular flap; its length equals length of snout. The vent is at a distance from tip of snout which equals two and three fourths times length of head. The anal fin, consisting of low, almost concealed, detached spines, begins close behind the vent; its base is five and one half times as long as the head. The lateral line drops rapidly downward from the upper angle of the gill opening to a point below the median line. Four long and strong fanglike teeth in the front of the upper jaw and one or two fangs on the front of the mandible, from seven to 10 sharp teeth in each side of each jaw; small teeth on the palatines, none on the vomer. D. 135; A. 109. The individual described was taken at Point Pleasant N. J. It is number 49224, U. S. National Museum. Color silvery.

The scabbard fish frequents warm seas and ranges north to Cape Cod and Lower California; it is very abundant in the West Indies. The fish is a voracious inhabitant of the high seas, and reaches the length of 5 feet. It is highly esteemed for food in Jamaica and at Pensacola; in Jamaica it forms the object of a very important hook and line fishery.

The scabbard fish is rarely seen in Gravesend bay. A young individual was obtained from John B. De Nyse's pound in August 1897. It had been captured by another fish while in the pound; but was rescued in good condition.

Family ISTIOPHORIDAE

Sailfishes

Genus ISTIOPHORUS Lacépède

Body slender, much compressed, covered with elongate scales; numerous small teeth on the jaws and palatines; ventral fins

present, of two or three rays; dorsal fin extremely high, continuous, as in the young of Tetrapturus and Xiphias, the rays very numerous, none being aborted, the hight of the first much greater than that of body; anal fin divided; air bladder sacculate; intestine short, nearly straight; sword usually shorter and less flattened than in Xiphias, the edge more rounded, the lower jaw more developed. The skin is also rougher. Large fishes of the warm seas; the number of species uncertain, probably several. (After Jordan and Evermann)

202 Istiophorus nigricans (Lacépède)

Sailfish; Spikefish

Makaira nigricans Lacépede, Hist. Nat. Poiss. IV, 688, 1803, Rochelle.

Histiophorus americanus Cuvier & Valenciennes, Hist. Nat. Poiss. VIII, 303, 1831, Brazil.

Istiophorus nigricans Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 891, 1896, pl. CXXXVII, fig. 376, 1900; Smith, Bull. U. S. F. C. XVII, 97, 1898; Goode, Proc. U. S. Nat. Mus. IV, 415, 1882.

Body compressed, highest in front, elongate, the greatest hight one seventh of the total length from tip of upper jaw to end of middle caudal rays; least hight of caudal peduncle one half of postorbital length of head; the upper jaw projecting beyond the lower a distance more than equal to greatest hight of body; the profile of the head descending very steeply from the origin of the dorsal to the eye; the lower jaw extending in front of the eye a distance equal to postorbital part of head. The dorsal fin begins on the nape and extends nearly the entire length of the back, but the first is separated from the second by a very deep and long notch and a short interspace; the longest spine equals one half the distance from the eye to the second dorsal and is one fourth of total length including caudal; the spinous dorsal forms almost a semicircle when fully expanded, with a deep anterior and a deeper median notch. The second dorsal base is one sixth as long as the head to tip of upper jaw; its longest ray is one half the length of postorbital part of head. The caudal is very deeply forked, its width at base one fourth of length of external rays, which are nearly one fourth of total without caudal. There are two small keels on the base of the caudal. The divided anal fin

begins under the 33d spine of the dorsal, the base of the two fins equaling one fourth the distance from tip of upper jaw to origin of second dorsal; the longest ray equals postorbital part of head; the second anal is similar to the second dorsal, but somewhat smaller. The ventral originates under the fifth spine of dorsal; its length is a little more than one fourth of total length to end of middle caudal rays. The pectoral is one half as long as the beak and eye combined and nearly equals the greatest hight of body. Eye small, one third of postorbital part of head. D. XLIV–7; A. 9 to 10–7; V. 2.

Color bluish black, paler below; dorsal dusky bluish, with numerous roundish black spots, from one third to one fourth the diameter of orbit, on its membrane.

The sailfish lives in the warmer parts of the Atlantic, ranging northward to France and, occasionally, to Cape Cod. Here described from a drawing of specimen taken at Woods Hole Mass.; color notes from Dr Jordan. The species reaches the length of 10 feet. It is valuable for food but rarely comes to our markets.

Genus TETRAPTURUS Rafinesque

Body much compressed, covered with rudimentary embedded scales; sword rounded on the edge; caudal keel double; small teeth in the jaws and on the palatines; ventral fins represented each by a single spine; dorsal fins separate in the adult, part of the middle rays being aborted, not greatly elevated, their hight not greater than the depth of the body; air bladder sacculated; vertebrae 12 + 12; intestine short, nearly straight; pyloric caeca very numerous. Large fishes of the deep seas. They swim in deep water, according to Poey, and pass Cuba in pairs in summer, bound for the Gulf of Mexico. Males smaller than females. (After Jordan and Evermann)

203 Tetrapturus imperator (Bloch & Schneider)

Billfish; Spearfish

Xiphias imperator BLOCH & SCHNEIDER, Syst. Ichth. 93, pl. XXI, 1801, Mediterranean.

Tetrapturus belone CUVIER & VALENCIENNES, Hist. Nat. Poiss. VIII, 280, 1833.

Tetrapturus albidus POEY, Memorias, II, 237, 1861, Havana; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 420, 1883.

Histiophorus belone GÜNTHER, Cat. Fish. Brit. Mus. II, 513, 1860.

Tetrapturus imperator GOODE, Proc. U. S. Nat. Mus. IV, 417, 1882; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 892, 1896; SMITH, Bull. U. S. F. C. XVII, 97, 1898.

Body similar in shape to that of the sailfish, its greatest depth contained six and one fourth times in total length without caudal; the least hight of caudal peduncle one fourth of the greatest depth. The head forms one third of total length without caudal; the upper jaw is exactly twice as long as the postorbital part of the head and extends beyond tip of mandible a space equal to length of eye and postorbital part of head combined; the maxilla extends far behind the eye; the eye is about one fifth as long as postorbital part of head. The dorsal begins on the nape, over the upper angle of the gill opening. The first dorsal occupies nearly one half of the total length without caudal; its anterior sixth is elevated and the rest of the fin is low; the longest spine (the fourth) is about one third as long as the head, the 10th is only one seventh as long as the head, and the last is scarcely one half as long as the eye. The interspace between the dorsals is three elevenths of length of head. The second dorsal base is one seventh as long as the head; its first ray is one and one half times as long as the eye, and its last ray is about equally long, but some of the intervening rays are shorter. The caudal fin is narrow, crescentic, its width at base of lobes one fourth of its length, the external rays equal to one fourth the distance from eye to caudal base. The first anal fin originates under the 29th ray of the dorsal; the base is one fourth as long as the head; the longest ray two sevenths as long as the head, the last ray minute. The interspace between the anals is one third as long as the head. The base of the second anal equals one third of postorbital length of head, the first and last rays equal, and as long as the base of the fin, the intervening rays shorter; two strong keels on the base of the caudal, each of them about twice as long as the eye. The ventral is very slender and long; it originates under the ninth ray of the dorsal, its length equal to postorbital part of

head. The pectoral insertion is under the sixth ray of the dorsal; the fin is nearly one half as long as the head; its position is in the lower fourth of the hight. The sword is rounded on the edges and much narrower than in the swordfish. D. III, 35 to 39–6; A. II, 13–6; V. I, 4; P. 19; vertebrae 12 + 12.

Color deep blue above, a little lighter on the flanks, passing into white below; fins intense blue, second anal and outside of pectoral clearer, first dorsal with rounded spots, more intense, of same color; iris clear blue, cornea blackish.

Body covered with lanceolate, embedded scales. The color notes here given are from Dr Goode's excellent description in *Proceedings of the U. S. National Museum*, IV, 420, 1882.

The spearfish is found in the West Indies and on our Atlantic coast, ranging northward to Cape Cod. Individuals more than 7 feet long have been taken, and the species is said to reach the length of 26 feet. At Woods Hole it is generally rare; but between 1885 and 1890 numbers were captured in the traps in Vineyard sound and Buzzards bay during July and August, according to Dr Hugh M. Smith. Most were caught in the trap farthest up Buzzards bay, at Quissett harbor.

The spearfish in our waters is said to resemble the swordfish in its movements and manner of feeding. Nothing is known of its breeding habits or its young. It is taken by means of hooks in deep water or by spearing at the surface. The hook fishing is not altogether a safe pastime, as the fishermen are often liable to be wounded or drowned by the fierceness and strength of the fish. Numerous instances are recorded of vessels having been pierced by the beak of the spearfish, and parts of such vessels containing the spear are exhibited in several museums.

The flesh of the spearfish is highly esteemed in some localities.

Family XIPHIIDAE

Swordfishes

Genus XIPHIAS Linnaeus

Swordfishes without teeth, and without ventral fins. Body somewhat compressed; dorsal fins two, the anterior beginning opposite the gill openings, falcate and elevated, its hight rather

less than that of the body, second dorsal very small, on the tail, opposite the small second anal. In the young, teeth are present, and the two dorsal fins are connected, the fin being elevated as in the species of Istiophorus. First anal similar to first dorsal, but smaller, less falcate, and far behind it; pectoral fins moderate, falcate; skin naked, more or less rough, specially in the young, which have rudimentary scales; sword flattened and trenchant; caudal keel single; intestines long, sinuous; air bladder simple; pelvic arch obsolete. Fishes of great size, reaching a weight of 300 to 400 pounds, the flesh red and rich in flavor, highly valued as food. (After Jordan and Evermann)

204 Xiphias gladius Linnaeus

Swordfish

Xiphias gladius Linnaeus, Syst. Nat. ed. X, I. 248, 1758, Europe; Bloch, Ichth. pl. 76, 1784; Mitchill, Am. Month. Mag. II, 242, Feb. 1818; Cuvier & Valenciennes, Hist. Nat. Poiss. VIII, 255, pl. 225, 226, 1831; De Kay, N. Y. Fauna, Fishes, 111, pl. 26, fig. 79, 1842; Günther, Cat. Fish. Brit. Mus. II, 511, 1860; Storer, Hist. Fish. Mass. 71, pl. XIII, fig. 2, 1867; Goode & Bean, Bull. Essex Inst. XI, 14, 1879; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 420, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 894, 1896; Smith, Bull. U. S. F. C. XVII, 97, 1898.

Body fusiform, tapering greatly toward the caudal fin, the head not long, but with a very long upper jaw produced into a beak or "sword," the greatest depth of the body one sixth of total length to base of caudal, the least hight of caudal peduncle nearly equal to length of eye. The upper jaw is three times as long as the rest of the head; the "sword" is broad and rather thin. The lower jaw extends in front of the eye a space equal to one half of postorbital part of head. The angle of the mouth is well behind the eye. The eye is circular, its diameter one third of postorbital part of head and about $\frac{1}{7}$ of total length of head. The dorsal begins over the upper angle of the gill opening; it is very high, nearly as high as the body, strongly falcate, its upper margin deeply concave, and the posterior rays very short. The distance between the dorsals is less than one third of length of head. The second dorsal is very small, its base only one half as long as the eye, and its hight one and four

fifths times its length of base; it is located a very little in front of the caudal keel. The caudal is crescentic, its external rays two fifths as long as the head. The caudal keel is single, median, its length nearly one sixth of length of head. The second anal is directly under the second dorsal and is of about the same size; the first anal is equidistant from the root of the caudal and the end of pectoral base; its base is as long as the caudal keel; its longest ray equals postorbital part of head, its last ray minute; the margin of the fin deeply concave. The pectoral origin is below the hind margin of the operculum; the base is narrow, about one fifth of length of fin, which is equal to depth of body. D. 39 to 40–2 to 4; A. 18 to 21–3; P. 20.

Color "above rich purplish blue, shading into whitish beneath, the sides and belly with a silvery luster. Fins dark bluish with silvery sheen except dorsal. Top of head rich purplish blue, the color extending upon the rostrum. Lower side of rostrum rich brownish purple. Eye deep blue."

The swordfish inhabits the Atlantic and comes near both coasts; it is most abundant between Cuba and Cape Breton, rather common in the Mediterranean, and is occasionally taken off southern California. The fish appear in the vicinity of Sandy Hook about June first, and the fishing season continues as far east as Marthas Vineyard and Nantucket shoals till about the middle of September. They disappear to the southward as soon as the cold winds begin to blow. They feed on mackerel, menhaden, and squid. They are often caught on trawl lines, but the chief means of capture is the harpoon.

The average length of swordfish is 10 feet, but individuals measuring 16 feet are on record. An individual weighing 750 pounds was killed in 1874 off Portland.

The flesh of this fish is very palatable, and the fishery is an important one as well as an exciting occupation.

Young swordfish have the skin covered with small, rough excrescences, the jaws much more nearly equal, and the dorsal and anal fins not divided into two separate parts.

Family CARANGIDAE

Crevalles

Genus OLIGOPLITES Gill

Body compressed, oblong or lanceolate; caudal peduncle slender, not keeled; head short, compressed, acute, occipital keel sharp; mouth rather large, with small, sharp teeth in bands on jaws, tongue, vomer and palatines, none on the pterygoids; jaws about equal, the upper not protractile, except in the very young, in which it is movable as in other Carangidae; maxillary very narrow, without distinct supplemental bone; gill rakers rather long; scales small, linear, and extremely narrow, embedded in the skin at different angles; lateral line unarmed; dorsal spines rather strong, three to five in number, nearly free in the adult; second dorsal very long, its posterior rays penicillated and nearly or quite disconnected, forming finlets; anal rather longer than soft dorsal, much longer than the abdomen, its last rays forming similar finlets, anal spines strong; ventral fins depressible in a groove; pectoral fins very short. Species few, in the tropical seas of America. (After Jordan and Evermann)

205 **Oligoplites saurus** (Bloch & Schneider)

Leather Jacket

Scomber saurus BLOCH & SCHNEIDER, Syst. Ichth. 321, 1801, Jamaica.

Chorinemus occidentalis GÜNTHER, Cat. Fish. Brit. Mus. II, 475, 1860; not *Gasterosteus occidentalis* LINNAEUS, Syst. Nat. ed. XII, I, 490.

Oligoplites occidentalis GILL, Proc. Ac. Nat. Sci. Phila. 166, 1863.

Scombroides occidentalis JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 447, 1883.

Oligoplites saurus JORDAN & GILBERT, op. cit. 973, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 898, 1896, pl. CXXXVIII, fig. 378, 1900; BEAN, Bull. Am. Mus. Nat. Hist. IX, 360, 1897; SMITH, Bull. U. S. F. C. XVII, 97, 1898.

Body elongate, much compressed, fusiform, its greatest hight contained three and two thirds times in total length without caudal (4 times in total to end of middle caudal rays), its width two sevenths of its hight and two fifths of length of head; least depth of caudal peduncle equals length of eye; head short, one fifth of total without caudal, its width three sevenths of its length; snout moderately pointed, its length about equal to orbit

and three sevenths of length of head; nostrils a little nearer to eye than to tip of snout, the anterior tubular and much smaller than the posterior; interorbital space convex but with a narrow, sharp, low keel, the width of the space equal to length of snout; the slender maxilla reaches to below the hind margin of the eye, the length of the upper jaw being a little more than the snout and eye combined; the mandible is two thirds as long as the head; a double series of small, sharp, curved, conical teeth in each jaw; vomer and palatines with bands of villiform teeth, an oblong patch of villiform teeth on the tongue; gill rakers about 15, mostly below the angle, the longest two thirds as long as the eye. The origin of the spinous dorsal is nearly over the tip of the pectoral and at a distance from tip of snout equal to one third of total length without caudal; the length of the base equals length of head without the snout; the first spine, depressible forward as well as backward, is nearly as long as the pupil, the third and fifth equal and nearly as long as the snout; the membrane behind the second to fifth spines one half the hight of spines; the interspace between the dorsals is very short. The second dorsal base equals one half the distance from eye to root of caudal; the fin is composed chiefly of detached or semidetached finlets; the longest ray is equal to length of snout and eye combined; the last finlet equal to length of eye. A well developed procumbent spine before the dorsal. The middle caudal rays are one third as long as the external rays, which are as long as the head. The anal fin is preceded by two strong, sharp, subequal spines, the second as long as the eye, both followed by membrane; the base of the anal equals that of the soft dorsal; the longest ray two fifths as long as the head, the fin composed chiefly of partly detached rays, the last ray about as long as the snout. The ventral origin is directly under the lower axil of the pectoral; the fin reaches to the vent and to a point below the third spine of dorsal. The pectoral is on the level of the lower margin of the eye; it is three fifths as long as the head and reaches to below the second spine of the dorsal. Head

naked; body covered with small, linear, embedded scales, which are irregularly arranged; fins scaleless. D. V, I, 20; A, II, I, 20; V, I, 5; P, I, 16. Top of head and back bluish; sides and lower parts silvery; fins, interopercle and iris yellow.

The leather jacket inhabits both coasts of tropical America, extending northward to Cape Cod and Lower California; it is very common in the West Indies and the Gulf of Mexico. Rare at Woods Hole, Mass., where only three examples were secured from 1874 to 1886 in traps and pound nets. At Newport R. I. the species is occasionally seen. The fish is rare in Gravesend bay; an example 9¾ inches long and 2½ inches deep was secured in John B. De Nyse's pound in the summer of 1896. The fish has no value as food.

Genus NAUCRATES Rafinesque

This genus differs from Seriola only in the reduction of the spinous dorsal to a few (four or five) low, unconnected spines. The young, called Nauclerus and Xystophorus, have the spines of the dorsals connected by membrane, and a more or less distinct strong spine at the angle of the operculum. A single pelagic species widely distributed in the open seas.

206 Naucrates ductor (Linnaeus)

Pilotfish

Gasterosteus ductor LINNAEUS, Syst. Nat. ed. X, I, 295, 1758, pelagic.

Scomber ductor MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 424, 1815.

Naucrates novehoracensis CUVIER & VALENCIENNES, Hist. Nat. Poiss. VIII, 325, 1831; DE KAY, N. Y. Fauna, Fishes, 112, 1842, and figure of *Naucrates ductor*, pl. 74, fig. 235.

Naucrates ductor CUVIER & VALENCIENNES, Hist. Nat. Poiss. VIII, 312, pl. 232, 1831; GÜNTHER, Cat. Fish. Brit. Mus. II, 374, 1860; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 443, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 900, 1896, pl. CXXXIX, fig. 379, 1900; SMITH, Bull. U. S. F. C. XVII, 97, 1898.

Naucrates indicus CUVIER, Règne Anim. Ill. Poiss. pl. 54, fig. 1, 1830.

Body fusiform, elongate, moderately thick, its greatest hight one fourth of total length without the caudal, and about equal to length of head, its width equal to three fifths of length of head; least depth of caudal peduncle about equal to long diameter of eye; head subconical, the snout obtuse, length of

head one fourth of total without caudal; snout two sevenths as long as the head; interorbital space convex, its width one half the length of head without the snout; maxilla expanded behind, reaching to below front of eye; mandible three sevenths as long as the head, reaching to below hind margin of eye; top of head and cheeks scaly, most of opercle and preopercle and all of interopercle naked; teeth in bands in the jaws but comparatively few and weak; vomerines and palatines also small and the lingual patch narrow; gill rakers stout, short, about 17 below the angle, the longest one half the length of eye; eye one sixth as long as the head. The spinous dorsal consists of four short, isolated spines, the first located nearly above the end of the base of ventral, the second and third spines the longest and about one fourth as long as the snout. The second dorsal begins midway between tip of snout and base of caudal; the base of the fin is nearly three times as long as the pectoral; the second ray is longest and one half as long as the head, the last ray as long as the eye; the upper margin of the fin is slightly concave. There is a long, fleshy keel on the caudal peduncle, longer than the postorbital part of the head. The caudal is deeply forked, its outer rays more than twice as long as the middle rays, both measured from base of caudal fin; the outer rays are as long as the head. The anal is preceded by two very small spines; the base of the fin is as long as the head; the longest ray is as long as the snout and eye combined, the last ray as long as the snout. The vent is under the 10th ray of the dorsal. The ventral fin is under the lower axil of the pectoral; its length is three fifths of length of head; when extended, it reaches to below the origin of the second dorsal. The pectoral fin is below the level of the eye; its length is about equal to length of ventral; it reaches to below the third spine of the dorsal. D. IV–I, 26 to 27; A. II, I, 16 to 17; V. I, 5; P. I, 20. Scales minute, about 55 rows between gill opening and origin of second dorsal. Color bluish with five to seven broad, dark bands, some of these extending on the fins; outer margin of caudal, ventral and pectoral nearly black.

The pilotfish is pelagic in all tropical and temperate seas; it is occasionally taken on our coast as far north as Provincetown Mass., but is not at all common. It was reported at Woods Hole Mass. by Prof. Baird in 1871. The young are developed in the open ocean and are so different in appearance from the adult that they have been described as a distinct genus. The fish has no economic value.

Genus SERIOLA Cuvier

Body oblong, moderately compressed, not elevated; occiput and breast not trenchant; head usually more or less conical, not very blunt; mouth comparatively large, with broad bands of villiform teeth on both jaws, tongue, vomer and palatines; a broad, strong, supplemental maxillary bone; premaxillaries protractile; scales small; lateral line slightly arched, forming a keel on the caudal peduncle, not armed with bony plates; sides of head with small scales; first dorsal with about seven low spines, connected by membrane; second dorsal very long, elevated in front; anal similar to the soft dorsal but not nearly so long, shorter than the abdomen, preceded by two very small free spines, which disappear in old fishes; no finlets; ventral fins very long; pectorals short and broad; gill rakers moderate. Species of moderate or large size.

207 Seriola zonata (Mitchill)

Banded Rudder Fish

Scomber zonatus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 427, 1815, New York Bay.

Seriola zonata CUVIER & VALENCIENNES, Hist. Nat. Poiss. IX, 213, 1833; DE KAY, N. Y. Fauna, Fishes, 128, pl. 9, fig. 26, 1842, Long Island Sound; GUNTHER, Cat. Fish. Brit. Mus. II, 465, 1860; STORER, Hist. Fish. Mass. 79, pl. XV, fig. 5, 1867; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 445, 1883; GOODE & BEAN, Bull. Essex Inst. XI, 16, 1879; BEAN, Bull. U. S. F. C. VII, 139, 1888; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 902, 1896; BEAN, Bull. Am. Mus. Nat. Hist. IX, 360, 1897; SMITH, Bull. U. S. F. C. XVII, 97, 1898.

Halatractus zonatus GILL, Proc. Ac. Nat. Sci. Phila. 442, 1862.

Body fusiform, compressed, moderately deep, its greatest depth one third of total length without caudal, its width less than one half the depth and equal to postorbital length of head; least depth of caudal peduncle equals one half length of snout;

head rather long and subconical, compressed, its length nearly equal to depth of body, nearly one third of total length without caudal; snout long and pointed, three eighths as long as the head, twice as long as the eye; interorbital space convex, indistinctly keeled, its width equal to length of snout; maxilla broadly expanded behind, reaching to below middle of pupil; mandible extending to below hind margin of eye; nostrils small, midway between tip of snout and eye; gill rakers 3-13, the longest two thirds as long as eye. The spinous dorsal originates a little behind the pectoral insertion and directly over the origin of the ventral; the base of the fin is as long as the postorbital part of the head; the first spine is much shorter than the second, the third or fourth is longest, about as long as the eye, the last is minute. The second dorsal is preceded by a very short, stout spine; the base of the fin equals its distance from the nostril; the longest ray is equal to postorbital part of head, the last ray one fourth as long as the head and reaches to the base of the caudal fin. A low, unarmed keel is developed on the caudal peduncle. The caudal fin is deeply forked, the outer rays being nearly as long as the head. The anal fin is preceded by a single very small spine; the longest ray is one third as long as the head, the last ray one fourth as long as the head; the margin of the second dorsal and anal fins is very slightly concave. The ventral is very long, reaching nearly to the vent, and to below the 13th ray of the dorsal, its length nearly equal to length of head. The pectoral reaches to below origin of second dorsal, its length equal to snout and eye combined. Lateral line strongly arched over the pectoral. D. VII, I, 37 to 38; A. I to II, i, 20 to 21; V. I, 5; P. i, 19.

Color bluish above, lower parts white; five or six broad dark bands on the sides, extending on the dorsal and anal fins; a narrow dark band obliquely from the spinous dorsal to the eye; spinous dorsal black; ventral black above, pale beneath; tips of caudal fin white. The bands become fainter or disappear in old fish.

The banded pilot is found on our east coast from Cape Ann to Cape Hatteras; it reaches the length of 2 or 3 feet. The

young are very common as far north as Cape Cod. The species is seldom used for food. The name, shark's pilot, is in use at Somers Point N. J.

Two individuals of the banded pilot were taken in Gravesend bay in September 1897. The species will live in captivity only when it has ample room. It feeds on small killifish, which it takes with a rush much like that of the brook trout.

208 Seriola lalandi Cuv. & Val. (?)

Amber Fish

Seriola lalandi Cuvier & Valenciennes, Hist. Nat. Poiss. IX, 208, 1833, Brazil; Günther, Cat. Fish. Brit. Mus. II, 463, 1860; Goode & Bean, Bull. U. S. F. C. I, 43, 1881; Jordan & Gilbert, Proc. U. S. Nat. Mus. 271, 1882; Jordan, Proc. U. S. Nat. Mus. 122, 123, 1884; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 903, 1896, pl. CXL, fig. 382, 1900; Bean, Bull. Am. Mus. Nat. Hist. IX, 160, 1897; Smith, Bull. U. S. F. C. XVII, 97, 1898.

Seriola gigas Poey, Memorias, II, 227, 1860, Cuba.

Zonichthys gigas Poey, Syn. Pisc. Cubens, 371, 1868.

Body oblong, moderately elongate, robust, its greatest hight contained four and one fourth times in the total length without caudal, its width seven times; the least depth of the caudal peduncle equals one seventh of the length of head; head long, conical, its length two sevenths of total length without caudal; snout long and somewhat pointed, its length two and one fifth times diameter of eye and one third of length of head; the jaws are equal in front; the maxilla reaches to below middle of pupil, and the length of the upper jaw is contained two and two sevenths times in length of head; the mandible is slightly more than one half as long as the head; the expanded end of maxilla exceeds the diameter of the eye, which is contained six and two fifths times in length of head; gill rakers 4+10, the longest nearly as long as the eye, very thin, much wider at base, and tapering gradually to a small, rounded point, very finely toothed on inner margin; teeth in broad, villiform bands in both jaws, an arrow-shaped patch with long, slender backward process on vomer, similar bands on palate and pharynx. The distance from snout to vertical from origin of spinous dorsal is nearly three times the length of base of the fin; the third and longest spine

is seven and one half times as long as the last spine and nearly one fourth as long as the head; the base of spinous dorsal is contained two and two sevenths times in length of head. The interspace between the two dorsals is less than the length of the eye. The second dorsal base is one and one half times as long as the head; the second ray is the longest and equals three times the length of the eye, the last ray about one third as long as the second. The anal origin is under the middle of the second dorsal and at a distance from the vent equal to one fourth the length of head; the anal base is as long as the head; the longest ray is nearly one half as long as the head, the last ray about equal to the last of the dorsal; the anal and second dorsal fins are elevated in front but very low for the most of their length. The ventral origin is directly under the insertion of the pectoral; the fin when extended reaches to below the last spine of dorsal, its length more than one half the length of head. The pectoral is broad at its base, somewhat falcate, its length nearly one half the length of head, the fin extending to below the seventh spine of the dorsal. D. VII, 36; A. I, 24; V. I, 5; P. 21. Scales about 24–160–30.

The ground color is gray with purplish iridescence. A golden bronze stripe beginning on the snout and continued behind the eye to the caudal in a nearly straight line, slightly above the median line. Another bronze stripe begins above the eye and extends to the first dorsal. In life two dark bands showed between the eyes and extended to the first dorsal. Sides and lower parts much mingled with silvery white; iris gray overlaid with golden yellow; pupil bluish black; all the fins colored like the body except the ventrals, which are whitish underneath, and gray mingled with white above.

The weight of the fish was 13 pounds 1½ ounces.

The specimen described was obtained by Mr De Nyse in Gravesend bay, July 15, 1896. For the purpose of comparison and verification of this identification, a series of measurements is here given in tabular form.

MEASUREMENTS

	Inches
Length, including caudal	33½
Length to end of middle caudal rays	30½
Length of external caudal lobes from pit	7
Length of middle caudal rays	2
Greatest depth of body	6¾
Least depth of caudal peduncle	1⅛
Greatest thickness of body	4
Length of head	8
Length of upper jaw	3½
Width across end of maxilla	1½
Length of mandible	4⅛
Length of snout	2¾
Diameter of eye	1¼
Diameter of pupil	⅝
Distance from snout to vertical from first dorsal origin	10¼
Length of first dorsal base	3½
Length of first spine	⅝
Length of second spine	1¼
Length of third (longest) spine	1⅞
Length of seventh spine	¼
Distance from snout to second dorsal (obliquely)	14¼
Length of second dorsal base	11¾
Length of second ray of second dorsal	3¾
Length of first ray	1⅞
Length of last ray	1⅜
Length of pectoral	3⅞
Length of ventral	4⅝
Distance from ventral origin to anal origin	10⅛
Distance from vent to anal origin	2

The amber jack here mentioned is supposed to be identical with the S. lalandi of Cuvier & Valenciennes, a species ranging regularly from Brazil to West Florida and occasionally northward in summer to Cape Cod. It grows to the length of 5 or 6 feet and the weight of 100 pounds, and it is a good food fish as well as a robust and vigorous prize for the angler.

Genus ELAGATIS Bennett

Body long and slender; second dorsal and anal long, each with one detached finlet composed of two rays behind the rest of the fin. Otherwise essentially as in Seriola. The short spines preceding the anal fin are somewhat remote from the rest of the fin. Branchiostegals 7; lateral line not armed; villiform teeth in bands in the jaw, on the vomer and the palatines.

209 Elagatis bipinnulatus (Quoy & Gaimard)

Runner

Seriola bipinnulata Quoy & Gaimard, Voyage Uranie, Zoöl. I, 363, pl. 61, fig. 3, 1824, Keeling islands.
Seriolichthys bipinnulatus Günther, Cat. Fish. Brit. Mus. II, 468. 1860.
Seriola pinnulata, Poey, Memorias, II, 233, 1860.
Elagatis pinnulatus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 446. 1883.
Elagatis bipinnulatus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 906, 1896; Bean, Bull. Am. Mus. Nat. Hist. IX, 361, 1897.

Body moderately elongate, slender, fusiform, its greatest depth one fourth of total length without caudal, its width three eighths of length of head; least depth of caudal peduncle equals diameter of eye; head conical, compressed, its width over opercles equal to length of postorbital part; a low occipital keel; snout moderately long, obtusely pointed, its length nearly equal to width of interorbital space, and contained three and one fourth times in length of head; lower jaw slightly projecting; maxilla almost reaching to below front of eye, the upper jaw one third as long as the head; mandible reaching nearly to below front margin of pupil, its length equal to postorbital part of head; interorbital space with a low keel between two shallow furrows, its width one third of length of head; eye one fourth the length of head (in young examples 5½ inches long), about one fifth in older fish; gill rakers 9+27, the longest one half as long as the snout. The spinous dorsal base is short, equal to postorbital part of head; the spines are very slender, closely placed, the longest not so long as the eye; the spines are depressible into a sheath; the origin of the fin is over the middle of the length of the pectoral. The soft dorsal originates about over the end of the ventral, midway between tip of snout and base of caudal; the longest ray is as long as the postorbital part of the head; the fin is shaped as in Seriola, the second half being very low, the last ray about two thirds as long as the eye; the fin is followed by two finlets, the longest as long as the eye. The caudal is deeply forked, the middle rays, from base of fin, one third as long as the outer rays, which are as long as the head; no keel on the caudal peduncle. The anal origin is under the 15th ray of the dorsal; the base of the fin is as long as the head;

the longest ray is three eighths as long as the head; the last ray two thirds as long as the eye; the fin is followed by two finlets, the longer as long as the eye. The ventral reaches a little beyond the origin of the soft dorsal; the length of the fin is equal to snout and eye combined. The pectoral is as long as the ventral; it reaches to below the last spine of the dorsal; the fin originates slightly in advance of the ventral insertion. Body covered with small, cycloid scales; head naked except on suborbital and postorbital regions; scales extending somewhat on bases of soft dorsal and anal fins. D. VI–I, 26 to 27, 2; A. II, I, 16 to 17, 2; V. I, 5; P. I, 20. Scales 16–110–20.

Color of upper parts bluish; lower parts pale yellowish; caudal fin yellowish, the margin dusky; ventrals and pectorals yellowish tinged with blue; a blue band as wide as the eye from orbit to upper margin of caudal peduncle; another from snout along lower margin of orbit and continuing to the caudal, passing above the pectoral.

The runner is recorded from the East Indian archipelago, Polynesia, and tropical parts of the Atlantic, straying northward in summer, rarely to Long Island, where specimens have been taken by Dr Seth E. Meek and John B. De Nyse. The fish attains to the length of 30 inches. The example captured by Mr De Nyse was taken in his pound at Gravesend bay Aug. 2, 1895; it is now preserved in the U. S. National Museum. The length of the specimen is about 15 inches. Young fish, about 4 to 6 inches long, are before me from Florida and Cuba.

Genus DECAPTERUS Bleeker

Body elongate, little compressed, almost perfectly fusiform; head short, pointed; mouth rather small; jaws about equal, the dentition feeble; maxillary rather broad, with a supplementary bone; premaxillaries protractile; scales moderate, enlarged for the whole length of the lateral line, but spinous and bony posteriorly only; second dorsal and anal each with a single detached finlet; free anal spines very strong; first dorsal well developed, persistent; pectorals comparatively short; abdomen rather shorter than anal fin; gill rakers long and slender. Species numerous.

210 Decapterus punctatus (Agassiz)

Scad; Round Robin

Scomber hippos Mitchill Trans. Lit. & Phil. Soc. N. Y. I, pl. V, fig. 5, 1815; Am. Month. Mag. II, 246, Feb. 1818, not of Linnaeus.

Caranx punctatus Agassiz, Spix. Pisc. Bras. 108, pl. 56a, fig. 2, 1829, Brazil; Cuvier & Valenciennes, Hist. Nat. Poiss. IX, 38, 1833; De Kay, N. Y. Fauna, Fishes, 122, pl. 73, fig. 233, 1842; Günther, Cat. Fish. Brit. Mus. II, 426, 1860.

Decapterus punctatus Poey, Syn. Pisc. Cub. 368, 1868; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 432, 1883; Bean, 19th Rep. Comm. Fish. N. Y. 256, 1890; Bull. Am. Mus. Nat. Hist. 362, 1897; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 907, 1896; Smith, Bull. U. S. F. C. XVII, 97, 1898.

Body scombriform, moderately elongate, its greatest depth one fifth to two ninths of total length without caudal, its width one half the length of head; least depth of caudal peduncle one sixth the length of head; head subconical, moderately compressed, its width one half its length, the snout obtusely pointed, as long as the eye, two sevenths as long as the head, the jaws subequal in front; maxilla expanded posteriorly, reaching to below front of eye; premaxilla projectile; mandible one half as long as the head, reaching to below front of eye; eye round, equal to snout, two sevenths of length of head; interorbital space convex, covered with small scales, its width equal to eye; a low, but distinct nuchal keel; opercular bones partly naked; gill rakers very numerous, long and slender; a small prominence on the shoulder girdle in front of base of pectoral; teeth in jaws uniserial, teeth on vomer and palatines, present or absent on tongue. The spinous dorsal originates over the 13th or 14th scale of the lateral line and slightly in advance of the middle of the pectoral; the base of the fin is as long as the head without the snout; the first spine is very slender, and as long as the eye; the longest spine as long as the snout and eye combined. The soft dorsal base is one third of total length including the caudal; the longest ray is one half as long as the head, the last ray two thirds as long as the eye; the fin is followed by a single finlet consisting of two rays, the length equal to length of eye. The middle caudal rays are two fifths as long as the outer, which are five sixths as long as the head. The anal base is one

third of total length without caudal; the fin is preceded by two short, stiff spines with a membrane behind each, the first of these spines two thirds as long as the eye; the longest anal ray is one half as long as the head and three times as long as the last ray; the fin is followed by a single two-rayed finlet which is three fourths as long as the eye. The ventral origin is equally distant from tip of snout and anal origin; the fin reaches to below the sixth spine of the dorsal, its length one half the length of head. The pectoral reaches to below the end of the spinous dorsal, its length three fourths of length of head. Head scaly except on the nasal, mandibular and preorbital regions; body covered with small scales; dorsal, anal and pectoral fins more or less scaly at base; lateral line with a long arch in its anterior one half, passing through enlarged scales in its curved part and armed with 41 scutes in its straight part. D. VIII–i, 31–I; A. II–i, 24 to 27–I; V. I, 5; P. i, 20.

Color slaty blue above, silvery below; a small, dark, opercular spot, smaller than the pupil; a series of 12 or 13 dark points in the curved part of the lateral line.

The dotted scad, or round robin, is a very common fish at the Bermudas and in the West Indies. On the east coast it is found from Cape Cod to Brazil, but only young or half grown specimens are taken on Long Island and around Cape Cod. The species grows to the length of 1 foot. In the Bermudas it is an important food fish and furnishes infinite sport for the small anglers.

Dr Mitchill illustrates it in fig. 5, pl. 5, of his *Fishes of New York*, and names it the hippos mackerel. In Dr De Kay's *New York Fauna* it is the spotted caranx. It is taken not uncommonly at Woods Hole Mass. The species appears to be rare in New York waters, as it was known to De Kay only from the descriptions of Mitchill and Cuvier. The fish has not been recognized in Gravesend bay, but it is abundant in August at Southampton L. I. and has been taken at Fire Island in October during the fall migration.

211 Decapterus macarellus (Cuv. & Val.)

Mackerel Scad

Caranx macarellus Cuvier & Valenciennes, Hist. Nat. Poiss. IX, 40, 1833 (Martinique); Günther, Cat. Fish. Brit. Mus. II, 426, 1860.

Decapterus macarellus Poey, Enumeratio, 79, 1875; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 433, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 909, 1896, pl. CXL, fig. 383, 1900; Bean, Bull. Am. Mus. Nat. Hist. IX, 362, 1897; Smith, Bull. U. S. F. C. XVII, 97, 1898.

Body elongate, fusiform, subterete, its greatest depth one fifth of total length, its width one half the length of head; least depth of caudal peduncle one eighth of length of head; head long, subconical, snout obtusely pointed, lower jaw slightly projecting, length of head one fourth of total without caudal; maxillary not quite reaching to front of orbit; the upper jaw equal to length of snout; mandible extending to below front of eye, its length equal to postorbital part of head; nostrils on top of head, nearer eye than to tip of snout; eye large, one fourth the length of head; interorbital space convex, its width equal to eye; a very low keel on top of head; no scales on nasal and preorbital regions; gill rakers 8+30, the longest two thirds as long as the eye. The spinous dorsal originates at a distance from tip of snout equal to one third the total length without caudal; the longest spine is one half as long as the head, the last spine minute. The interspace between the two dorsals is one half the diameter of eye. The second dorsal base equals one third of total length to end of middle caudal rays; the anterior one fourth of the fin is much higher than the rest, the longest ray one third of length of head, the last ray one half as long as the snout; the fin is followed by a single finlet of two rays, the longer two thirds as long as the eye. The caudal fin is moderately forked, the middle rays, from base of fin, four sevenths as long as the outer, which are equal to snout and eye combined. The anal fin is preceded by two short, sharp spines, the first longer, one half as long as the snout; the rays begin under the ninth ray of the second dorsal; the base is as long as the distance from ventral origin to preanal spines; the longest ray about one third as long as the head, the last ray one half as long as the snout; the fin is followed by a single two-rayed finlet,

which is two thirds as long as the snout. The ventral insertion is under the lower axil of the pectoral; the fin extends to below the fifth spine of the dorsal, its length equal to postorbital part of head. The pectoral extends to below the sixth spine of the dorsal, its length equal to the head without the snout. Small scales on nape; nasal, preorbital and mandibular regions naked; sides of head mostly with enlarged, thin scales; small scales on opercle; margin of subopercle finely serrate; body covered with small scales; anterior half of lateral line with a slight curve, the scales prominent; posterior half of lateral line straight and armed with about 31 keeled scutes, the armed portion constituting the second half of the length. D. VIII–i, 34–1; II–i, 28–1; V. I, 5; P. i, 24. Scales 15–100+31–18.

Color slate blue or plumbeous above, silvery below; a small, black opercular spot, smaller than pupil; upper axil of pectoral black.

The mackerel scad inhabits the warm parts of the Atlantic, ranging northward in summer to Cape Cod. It has not yet been reported in Gravesend bay, but was seined in abundance in the Atlantic at Southampton L. I. Aug. 31, 1897, associated with Decapterus punctatus, young Scomber, Pomatomus, Rhombus, Clupea, Etrumeus, two species of Stolephorus, and Paralichthys.

The species grows to the length of 1 foot. It is excellent for food but large individuals seldom reach our coast. It is said to be more abundant along the south Florida coast, where it lives in shallow water and in harbors, usually moving about in small schools. At Key West the fish are caught in seines, and are eaten.

Genus TRACHURUS Rafinesque

Body rather elongate, somewhat compressed, not elevated, tapering to a slender caudal peduncle, which is as broad as deep; scales present, not very small; lateral line armed throughout with plates, those on the caudal peduncle larger and spinous; an accessory dorsal branch to the lateral line; snout rather long; mouth moderate; minute teeth mostly in single series on

jaws, vomer and palatines; dorsals two, the first preceded by a procumbent spine, no finlets; two strong spines before the anal, connected by membrane; pyloric caeca numerous. About 4 species known; found in all warm seas.

212 Trachurus trachurus (Linnaeus)

Gascon; Saurel

Scomber trachurus Linnaeus, Syst. Nat. ed. X, I, 298, 1758, Mediterranean.
Caranx trachurus Cuvier & Valenciennes, Hist. Nat. Poiss. IX, 11, pl. 246, 1833; Cuvier, Règne Anim. Ill. Poiss. pl. 57, fig. 1.
Trachurus saurus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 912, 1883.
Trachurus trachurus Bloch, Naturgesch. Ichth. II, 138, pl. 36, 1784; Günther, Cat. Fish. Brit. Mus. II, 419, 1860 (in part); Lütken, Spolia Atlantica, 125, 1880; Jordan & Gilbert, Proc. U. S. Nat. Mus. 269, 1882; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 910, 1896, pl. CXL, fig. 384, 1900.

Body strongly compressed and moderately deep, the depth contained four times in the length of the body; head rather long, its length being contained three and one half times in that of the body; eye large, equal to snout, its length contained four times in that of the head; mouth moderate, the maxillary reaching the front of the eye; arch of lateral line short, reaching scarcely beyond pectoral, one and one third in the straight part, the plates high, nearly as high anteriorly as posteriorly, their hight more than half of eye. Greenish, sides silvery; a dusky opercular spot. Length one foot. North Atlantic, chiefly on the coasts of Europe, south to Spain and Naples; it is very rare on our coast, recorded from Newport R. I., Pensacola, and Cape San Lucas. D. VIII–I, 29; A. II–I, 28; scutes 40+37.

The saurel, or scad, ranges north to the Trondhjem fiord, latitude 65°, and is said to occur as far south as Portugal. On the coast of Holland it is known as the *marse banker*, or *hors*. It is interesting to American ichthyologists, since the similarity of its habits to those of the menhaden caused the latter fish to be called among the early Dutch colonists of New York by the same name.

The scads are described by European writers as occurring on those coasts in enormous schools, moving like menhaden but with feeding habits similar to those of our bluefish. They are fairly

good food fishes, but of small size, seldom exceeding 1 foot in length. Only a few specimens have been recorded on our Atlantic coast from Newport R. I., Pensacola Fla., and Cape San Lucas, Lower California.

Genus TRACHUROPS Gill

This genus is close to Caranx, differing in the more elongate form and specially in the structure of the shoulder girdle, which has a deep cross furrow at its junction with the isthmus, with a fleshy projection above the furrow.

213 Trachurops crumenophthalmus (Bloch)

Big-eyed Scad; Goggler

Scomber crumenophthalmus BLOCH, Ichth. pl. 343, 1793.

Scomber plumieri BLOCH, op. cit. pl. 344, 1793, Antilles; STORER, Syn. Fish. N. A. 100, 1846.

Caranx crumenophthalmus LACÉPÈDE, Hist. Nat. Poiss. IV, 107, 1803; CUVIER & VALENCIENNES, Hist. Nat. Poiss. IX, 62, 1833; GÜNTHER, Cat. Fish. Brit. Mus. II, 429, 1860; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 434, 1883.

Trachurops crumenophthalmus JORDAN & GILBERT, Proc. U. S. Nat. Mus. 196, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 911, 1896, pl. CXLI, fig. 385, 1900; BEAN, Bull. Am. Mus. Nat. Hist. IX, 362, 1897; SMITH, Bull. U. S. F. C. XVII, 97, 1898.

Body oblong elongate, little compressed, the back not elevated. The depth is contained three and one half times in the length. Head elongate, rather pointed, the lower jaw projecting; maxillary reaching past the front of the eye, which is very large, longer than snout, much deeper than cheeks, and greater than the interorbital width. The length of the head is contained three and one half times, while that of the eye is contained three times in the length of the body. A single series of teeth in each jaw, very weak teeth on vomer and palatines, a patch of teeth on tongue. Shoulder girdle near isthmus with a fleshy projection, in front of which is a deep cross furrow; adipose eyelid largely developed; scales comparatively large; cheeks and breast scaly; gill rakers long and numerous; lateral line scarcely arched, its scutes weak, but little carinated; dorsal spines slender; free anal spines strong; pectorals falcate, shortish, about one and one seventh in the head; an angle at lower posterior part of opercular region as in Clupea. Bluish olive above, silvery

below; a faint opercular spot. Length about 2 feet. D. VIII–I, 26; A. II–I, 22; scutes 35.

Found on both coasts of tropical America, and extending northward on our east coast to Cape Cod; common in the West Indies and on the west coast of Mexico; also found on the coast of Africa and in most tropical seas; abundant in the Caribbean sea in winter.

This is the goggler or goggle-eyed jack of the Bermudas and the *Cicharra* of Cuba. In the Bermudas it is a food fish of some importance. In January 1885 a few individuals were seined at the island of Cozumel, off Yucatan. The fish was found to be excellent for the table.

At Woods Hole Mass., according to Dr Smith, it is common every year from about October 15 to November 15, the individuals taken measuring from 4 inches to 6 inches in length.

July 25, 1901, a single example, about 4 inches long, was picked up dead on the ocean beach opposite Clam Pond cove; one of a number of little fish which had probably been driven ashore by bluefish or some other predatory species, for the fish had recently died, and there had been no storm. Seven species in all were found in a distance of about 2 miles; they were common mackerel, bluefish, mackerel scad, two species of anchovy, young sea herring, and the big-eyed scad.

The big-eyed scad is taken in the fall in Gravesend bay. It was found Aug. 31, 1897, in the surf at Southampton L. I. This fish will not endure close confinement, but will live within suitable limits of temperature in large bodies of water. In captivity it feeds on small killifish, shrimp, and chopped clams.

Genus CARANX Lacépède

Body ovate or oblong, compressed, the back sometimes considerably elevated, sometimes little arched; head moderate or rather large, more or less compressed; mouth moderate or large, oblique; maxillary broad, with a well developed supplemental bone, extending to below eye; premaxillaries protractile; teeth developed in one or few series, unequal, or at least not in villiform bands, villiform teeth usually present on vomer, palatines,

and tongue, wanting or deciduous in some species; gill rakers long; eye large, with an adipose eyelid; dorsal spines rather low, connected; second dorsal long, usually elevated in front, both fins depressible in a groove; anal fin similar to second dorsal and nearly as long, preceded by two rather strong spines, its base longer than the abdomen; caudal fin strongly forked, the peduncle very slender; ventral fins moderate; pectorals falcate; no finlets; scales present, mostly very small; lateral line with its posterior part armed with strong bony plates, which grow larger on the tail, each plate armed with a spine, a short dorsal branch of lateral line usually present; preopercle entire in the adult, serrate in the young, usually with a membranaceous border. Species very numerous in all warm seas.

Subgenus TRICHOPTERUS Rafinesque

214 **Caranx hippos** (Linnaeus)

Crevallé

Scomber hippos LINNAEUS, Syst. Nat. ed. XII, I, 494, 1766, Charleston, South Carolina.

Caranx carangus CUVIER & VALENCIENNES, Hist. Nat. Poiss. IX, 91, 1833; GÜNTHER, Cat. Fish. Brit. Mus. II, 448, 1860.

Caranx defensor DE KAY, N. Y. Fauna, Fishes, 120, pl. 24, fig. 72, 1842; HOLBROOK, Ichth. S. C. 87, pl. 12, fig. 1, 1860.

Carangus hippos GILL, Proc. Ac. Nat. Sci. Phila. 433, 1862; GOODE & BEAN, Bull. Essex Inst. XI, 16, 1879.

Caranx hippus JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 437, 1883; JORDAN & GILBERT, Proc. U. S. Nat. Mus. 200, 1883.

Caranx hippos BEAN, Bull. U. S. F. C. VII, 139, 1888; Bull. Am. Mus. Nat. Hist. IX, 362, 1897; 52d Ann. Rept. N. Y. State Mus. 103, 1900; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 920, 1896, pl. CXLI, fig. 387, 1900; MEARNS, Bull. Am. Mus. Nat. Hist. X, 318, 1898; SMITH, Bull. U. S. F. C. XVII, 98, 1898.

Body oblong, the anterior profile very strongly arched. The depth is contained two and one half times in the length. Head large and deep, its length being contained three and one half times in that of the body; mouth large, low; lower jaw prominent, maxillary extending to nearly opposite posterior border of eye, two and one third in head; teeth in upper jaw in a broad villiform band, an outer series of large, wide set, conical teeth, teeth of lower jaw in one row, a distinct canine on each side of symphysis; villiform teeth on vomer, palatines,

pterygoids, and tongue; lateral line with a wide arch, its length one and one third in straight part, the angle under fifth dorsal ray, plates not covering all of the straight part, lateral line (scutes) about 30; dorsal spines short, rather stout; gill rakers stout, rather long, 15 below angle; occipital keel sharp; eye not very large; pectoral falcate, one fifth longer than head; breast naked, with only a small triangular patch of scales in front of ventrals; caudal lobes equal, nearly as long as head. D. VIII–I, 20; A. II–I, 17.

Olivaceous above, sides and below golden; a large, distinct black blotch on opercle, bordered behind with pale; a large faint black spot on lower rays of pectorals, the latter sometimes wanting in young; axil of pectoral with a black blotch; edge of soft dorsal black; upper edge of caudal peduncle dusky.

The crevallé is found on the east coast from Nova Scotia southward, ranging to the West Indies and Brazil. The young are very common along the coast of southern New England in summer. De Kay calls it the yellow caranx, and Mitchill mentions it as the yellow mackerel. The specimens seen by both these authors came from the bay of New York.

At Woods Hole Mass. the young arrive in July and leave in October. In Great Egg Harbor bay, N. J., young individuals were taken sparingly in August. De Kay records the species as abundant in New York bay in September and October. The writer saw several examples from a fish trap at Islip L. I., Oct. 1, 1890.

Young crevallé make a croaking sound when captured in a net or held in the hand.

On the gulf coast of Florida, Alabama and Mississippi the fish is migratory, just as it is here; it makes its appearance in April, spawns in July or August, and then disappears and is replaced by the young. It feeds on small fish, which it pursues eagerly, and is preyed on by sharks and porpoises.

It grows to the length of 15 inches and is highly prized for food.

The crevallé can be successfully kept in captivity in large pools with a temperature above 50° in winter. The fish occasionally school together under a large shark and follow it about.

Subgenus PARATRACTUS Gill

215 Caranx crysos (Mitchill)

Yellow Mackerel

Scomber crysos MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 424, 1815, New York.

Caranx pisquetus CUVIER & VALENCIENNES, Hist. Nat. Poiss. IX, 97, 1833, San Domingo, Cuba, and Brazil; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 435, 1883.

Paratractus pisquetus GILL, Proc. Ac. Nat. Sci. Phila. 432, 1862; GOODE & BEAN, Bull. Essex Inst. XI, 16, 1879.

Caranx chrysos STORER, Hist. Fish. Mass. 75, pl. XIV, fig. 3, 1867; GÜNTHER, Cat. Fish. Brit. Mus. II, 445, 1860.

Caranx chrysus JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 970, 1883; BEAN, 19th Rep. Comm. Fish. N. Y. 256, pl. VII, fig. 10, 1890.

Caranx crysos DE KAY, N. Y. Fauna, Fishes, 121, pl. 27, fig. 85, 1842; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 921, 1896, pl. CXLII, fig. 388, 1900; BEAN, Bull. Am. Mus. Nat. Hist. IX, 362, 1897; SMITH, Bull. U. S. F. C. XVII, 98, 1898.

Body oblong, moderately elevated, the dorsal and ventral outlines about equally arched. The depth of the body is contained about three and one fourth times in the length. Profile forming a uniform curve. The length of the head is contained three and three fourths times in the length of the body. Snout rather sharp; mouth slightly oblique, a little below axis of body; maxillary reaching about to middle of orbit; teeth comparatively large, a single series in lower jaw, upper jaw with an inner series of smaller teeth, no canines, teeth on vomer, palatines and tongue; eye rather small, shorter than snout, three and one half in head; gill rakers long and numerous; pectoral as long as head, barely reaching anal, rarely longer than head in certain specimens from Key West, possibly referable to C. caballus; scales moderate; cheeks and breast scaly; lateral line with a weak arch anteriorly, which is about half the length of straight portion, lateral scutes numerous, developed on whole straight part of lateral line, lateral line 50 (scutes). D. VIII–I, 24; A. II–I, 19.

Greenish olive, golden yellow or silvery below; a black blotch on opercle; fins all pale. An individual 3½ inches long, taken

at Beesleys Point N. J. Aug. 11, 1887, showed the following colors: caudal yellow; basal half of elevated part of anal yellow; cheeks and lower half of sides also yellow; a black opercular spot, but none on pectoral; several narrow pale bars on sides; tip of elevated part of soft dorsal dusky; membrane between dorsal spines dusky; iris copper color.

The yellow mackerel is a widely distributed fish in warm seas; it is recorded from the East Indies, both coasts of tropical America, and northward to Cape Ann and the Gulf of California. The young are common at Woods Hole Mass., where they appear in July and become most abundant in October. Individuals 1 inch long have been obtained there about July 1; larger fish occur in the fall. In August 1898 only a few young ones were secured in Great South bay and at Southampton L. I.

The fish probably spawns in west Florida in May in the salt water bayous, as the young fish are seen coming out of such places in schools in the fall on their way to the sea. Fish weighing about a pound or two are considered equal to pompano for the table, but large fish are not esteemed, the flesh being dark and almost tasteless. The species reaches the weight of 20 pounds.

The yellow mackerel resembles the big-eyed scad in its endurance of captivity and its feeding habits. At the end of November it has been known to thrive in a pool containing about 50,000 gallons of water in company with the crevallé, the big-eyed scad and other species.

Genus ALECTIS Rafinesque

Body rhomboid, deep, strongly compressed, more or less completely covered with minute embedded scales, sometimes apparently naked; scutes on the straight part of the lateral line enlarged, bony and spinous, as in Caranx, but much less developed; mouth moderate, with bands of villiform teeth on jaws, vomer, palatines and tongue; first dorsal fin little developed, the spines short and rudimentary, mostly disappearing with age; soft dorsal and anal similar to each other; the first five or six

rays of each fin elongate and villiform in the young, becoming shorter with age; ventral fins elongate in young, short in the adult; pectorals falcate; no finlets; caudal peduncle narrow, the caudal widely forked; gill rakers moderate, stout. This genus is not essentially different from Caranx, the great change in form arising from no important modification of the skeleton. The changes due to age are surprisingly great, as Dr Lütken has shown, the characters of the nominal genera being chiefly stages in the growth of individuals. The young individuals are almost orbicular in form, with the filaments excessively long. Tropical seas.

216 Alectis ciliaris (Bloch)

Threadfish; Cobblerfish; Shoemakerfish

Zeus ciliaris Bloch, Ichth. VI, 29, pl. 29, 1788, East Indies.
Zeus crinitis Akerly, Amer. Jour. Sci. Arts, XI, 144, pl. 2, 1826, Shoreham.
Blepharis crinitus De Kay, N. Y. Fauna, Fishes, 123, pl. 25, fig. 76, 1842.
Blepharichthys crinitus Gill, Proc. Ac. Nat. Sci. Phila. 262, 1862.
Caranx sutor Günther, Cat. Fish. Brit. Mus. II, 454, 1860.
Alectis crinitus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 438, 1883.
Alectis ciliaris Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 931, 1896; Bean, Bull. Am. Mus. Nat. Hist. IX, 362, 1897; 52d Ann. Rept. N. Y. State Mus. 103, 1900; Smith, Bull. U. S. F. C. XVII, 98, 1898.

Body oval, much compressed, highest at the elevated bases of the dorsal and anal fins. The depth of the body is contained from one and one fourth to two times in the length of the body. The length of the head is contained three and one third times in that of the body. Mouth nearly horizontal in the adult, very oblique in the young; preorbital very deep; first rays of dorsal and anal filamentous, exceedingly long, in the young much longer than body, becoming shorter with age; lateral with a wide arch, the curved part about equal to the straight part; scaly sheath of fins little developed; scutes 12, scutes becoming stronger and blunter with age; ventrals broad; occipital keel sharp; pectorals long and falcate, longer than head. D. VI–I, 19; A. II–I, 16. Bluish above, golden yellow below; a dark blotch on opercle; a black spot on orbit above; a black blotch on dorsal and anal in front.

The threadfish is found on the east coast from Cape Cod to the Caribbean sea and on the Pacific coast of tropical America. In

western Mexico it attains to the length of 3 feet and is used for food. At Woods Hole Mass., it is usually uncommon, but sometimes abundant, appearing about the middle of June and remaining till November.

De Kay described a specimen from Long Island sound, the only one observed by him. One was taken in a pound net at Islip Aug. 18, 1898, by W. F. Clock. The threadfish enters Gravesend bay occasionally in summer. In captivity it will not endure a water temperature much below 60°.

Genus VOMER Cuv. & Val.

This genus is closely allied to Caranx, from which it differs only in its distortion of form, and in its weak teeth and very low fins. Body broad, ovate, very strongly compressed, all the outlines sharply trenchant; head very gibbous above the eyes, its anterior profile vertical; lateral line strongly arched, its posterior part with very weak shields; scales minute, rudimentary; soft dorsal and anal extremely low, not falcate. Young much deeper in form than the adult, all the fins higher, resembling Selene. Warm seas.

217 Vomer setipinnis (Mitchill)

Horsefish; Moonfish

Zeus setapinnis Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 384, pl. I, fig. 9, 1815, New York.

Vomer brownii Cuvier & Valenciennes, Hist. Nat. Poiss. IX, 189, pl. 256, 1833, New York & West Indies; De Kay, N. Y. Fauna, Fishes, 127, pl. 25, fig. 78, 1842.

Argyreiosus setipinnis Günther, Cat. Fish. Brit. Mus. II, 459, 1860.

Selene setipinnis Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 440, 1883.

Vomer setipinnis Gill, Proc. Ac. Nat. Sci. Phila. 436, 1862; Jordan & Gilbert, Bull. 47, U. S. Nat. Mus. 934, 1896, pl. CXLIV, fig. 392, 1900; Bean, Bull. Am. Mus. Nat. Hist. IX, 362, 1897; Smith, Bull. U. S. F. C. XVII, 98, 1898.

Body oblong, rhombic, less elevated than in Selene vomer; profile anteriorly nearly vertical, highest above eye, snout somewhat protruding, belly mostly arched in young; mouth oblique; maxillary reaching vertical from front of orbit. The depth of the body is contained twice in the length in an adult but only from one and one fourth to one and three fourths in the young. The length of the body is three and one fourth times the length

of the head. Scutes 20; ventral fins minute; dorsal and anal very low, specially in adult, the long rays disappearing very early; pectorals falcate, about as long as head. D. VIII-I, 21 or 22; A. II–I, 19 or 20.

Color above plumbeous or greenish; sides and lower parts lustrous silvery; membrane of second dorsal light yellow at base, the membrane with minute black points; pectorals greenish, tinged with dusky; young with a black blotch, smaller than the eye, at the beginning of the straight part of the lateral line.

The horsefish inhabits the seas of tropical America, ranging from Maine to Brazil and from Lower California to Peru. In summer it is sometimes abundant as far north as Saco Me., and at Woods Hole Mass., in Buzzards bay and Vineyard sound, but sometimes it is rare in those waters. When present, it appears in August and remains till September. The fish is also reported in western Africa. Mitchill calls it the bristly dory. He records it from New York bay. De Kay states that it appears in New York waters in July and August, and that it is esteemed for food. An individual was brought from Gravesend bay Oct. 21, 1896, and a young example, known there as dollarfish, was received from the same locality Oct. 22, 1896.

The species reaches the length of 1 foot. It is esteemed an excellent article of food. It finds its way to New York in considerable numbers every year but is rarely seen in other markets. Nothing is known of its breeding habits.

The horsefish has several additional common names: sunfish, jorobado (Cuba), blunt-nosed shiner, pug-nosed shiner, and humpbacked butterfish.

Genus SELENE Lacépède

Body very closely compressed and much elevated, the profile very oblique or nearly vertical; edges of body everywhere trenchant, specially anteriorly; head short and very deep, the opercle very short, and the preorbital extremely deep; an abrupt angle at the occipital region; mouth rather small; premaxillaries protractile, fitting into a notch between the bases of the maxillaries; maxillaries broad, each with a supplemental bone; tongue nar-

row, free; teeth minute, on jaws, tongue, vomer, and palatines; gill rakers long and slender; spines of fins usually weak, more or less filamentous in the young; free anal spines immovable, sometimes obsolete in the adult; soft fins falcate, much elevated; no finlets; head naked; scales minute; lateral line wholly unarmed. Coloration silvery. Tropical seas. Notwithstanding its extraordinary form, this genus differs in no important regard from Caranx.

218 Selene vomer (Linnaeus)

Lookdown; Moonfish

Zeus vomer Linnaeus, Syst. Nat. ed. X, I, 266, 1758, America.

Argyreiosus vomer Lacépède, Hist. Nat. Poiss. IV, 566, 1803; De Kay, N. Y. Fauna, Fishes, 124, pl. 75, fig. 238, 1842; Günther, Cat. Fish. Brit. Mus. II, 458, 1860; Gill, Proc. Ac. Nat. Sci. Phila. 437, 1862; Bean, 19th Rep. Comm. Fish. N. Y. 256, 1890.

Argyriosus vomer Goode & Bean, Bull. Essex Inst. XI, 16, 1879.

Selene argentea Lacépède, Hist. Nat. Poiss. IV, 560, pl. 9, fig. 2, 1803, (adult).

Zeus capillaris Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 383, pl. II, fig. 2, 1815, (young), New York.

Zeus rostratus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 384, pl. II, fig. 1, 1815, (young), New York.

Zeus geometricus Mitchill, Ali. Month. Mag. II, 245, Feb. 1818, (adult), New York.

Argyreiosus capillaris De Kay, N. Y. Fauna, Fishes, 125, pl. 27, fig. 82, 1842, New York.

Selene vomer Cuvier & Valenciennes, Hist. Nat. Poiss. IX, 177, 1833; Brevoort, Ann. Lyc. Nat. Hist. N. Y. V, 68, pl. 4, 1853; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 439, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 936, 1896, pl. CXLIV, fig. 393, (young), pl. CXLV, fig. 393*a*, adult, 1900; Bean, Bull. Am. Mus. Nat. Hist. IX, 363, 1897, 52d Ann. Rept. N. Y. State Mus. 103, 1900; Smith, Bull. U. S. F. C. XVII, 98, 1898.

Selene gallus Bean, Bull. U. S. F. C. VII, 139, 1888.

The depth of the body is contained one and one half times in the length; while the length of the head is contained three times in the length of the body. Diameter of eye, length of opercle, and distance from eye to profile about equal; eye twice in maxillary, two and one half in preorbital; mandibles very deep, the dentary bones thin, approximate; one or two of the dorsal spines greatly elongate and filamentous in the young, short in the adult; ventrals variable in length, usually as long as the eye in the adult, variously elongate in partly grown specimens; the

long dorsal rays contained twice in the length of the body; the pectoral two and three fourths times; and the long anal rays two and two thirds. D. VII–I, 22; A. II–I, 20. Bluish above, sides and below silvery with golden reflections; anterior edge of soft dorsal black; axil dusky.

Examples measuring from 3 to 4 inches, taken at Beesleys Point N. J. Aug. 10–11, 1887, showed the following colors: silvery; five golden bands on sides, one of which extends through the eye and below it half way to maxilla, or slightly farther. The second and third soon fade, persisting only above median line and at their lower extremities.

The example taken August 11 is 4 inches long; its longest first dorsal ray measures 6⅝ inches; the other is 3 inches long, and has a filamentous spine measuring 5 inches.

The lookdown is found on both coasts of tropical America and in temperate parts of the Atlantic north to Cape Cod and Lower California. At Woods Hole Mass. it is rare, but a few are taken annually in traps and seines, usually in September. Storer describes a specimen 5½ inches long from New Bedford Mass. Mitchill mentions the fish under two names, hair-finned dory and rostrated dory, but gives no special locality. De Kay calls it the hair-finned argyreiose and notes its appearance in New York waters about the latter end of August and its capture in gill nets. The writer obtained four young examples by seining at the Blue Point Lifesaving station Oct. 7, 1890. Aug. 29, 1898, he took another young individual in the seine at Duncan's creek, Great South bay.

The fish is interesting only from its silvery colors and singular shape, which make it a great attraction for the aquarium. Three individuals of the moonfish were obtained from Gravesend bay Sep. 8 and 29, 1897. In November they were transferred to a tank in which the water was at a temperature of 68° to 70° F, and they were successfully kept through the winter.

Genus CHLOROSCOMBRUS Girard

Body oblong ovate, closely compressed, but not elevated; the abdomen prominent anteriorly, its curve being much greater

than the curve of the back; occiput and thoracic region trenchant; caudal peduncle very narrow, the fin widely forked; scales small, smooth; lateral line arched in front, unarmed, or with a few small plates; head nearly naked; preorbital low; mouth rather small, oblique, lower jaw scarcely projecting, upper jaw protractile; maxillary broad, emarginate behind, with a large supplemental bone; jaws, vomer and palatines with feeble teeth, mostly in single series; first dorsal of feeble spines, connected by membrane; second dorsal and anal long and low, similar, much longer than the short abdomen; no finlets.

219 **Chloroscombrus chrysurus** (Linnaeus)

Casabe; Bumper

Scomber chrysurus Linnaeus, Syst. Nat. ed. XII, I, 494, 1766, Charleston.
Seriola cosmopolita Cuvier & Valenciennes, Hist. Nat. Poiss. IX, 219, pl. 259, 1833; De Kay, N. Y. Fauna, Fishes, 129, pl. 74, fig. 237, 1842.
Chloroscombrus caribbaeus Girard, Mex. Bound. Surv. Zoöl. 21, pl. 9, fig. 6, 1859, Joseph Island, Texas.
Micropteryx chrysurus Günther, Cat. Fish. Brit. Mus. II, 460, 1860.
Chloroscombrus chrysurus Gill, Proc. Ac. Nat. Sci. Phila. 437, 1862; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 441, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 938, 1896, pl. CXLV, fig. 394, 1900.

The depth of the body is contained two and one third times in the length; length of head contained three and three fourths times in the length of the body; head rather deep than long; opercles very short; snout short; mouth very oblique; maxillary reaching anterior margin of eye; eye very large, longer than snout, about three in head; chord of curved part of lateral line scarcely longer than head, one and two thirds to one and three fourths times in length of straight part; lateral line wholly unarmed; caudal peduncle longer than deep, its diameter less than that of the eye; ventrals very small, fitting into a groove in which the vent is situated; pectorals long, falcate, one third the length. D. VIII–I, 26; A. II–I, 26.

Color of upper parts pale greenish; sides of head and body silvery iridescent; a nearly square black blotch on caudal peduncle above; dark spots on opercle and axil of pectoral; inside of mouth black; first dorsal translucent with a yellow tinge anteriorly and with minute dusky points, second dorsal translucent

at base, numerous black points anteriorly, margin yellowish, pectoral yellowish, ventral white, preanal spines and connecting membrane white, anal translucent at base, rest of fin yellowish with a few dusky points.

The casabe is a small fish of wide distribution along our east coast, ranging from Cape Cod to Brazil; it is common in the Gulf of Mexico, the Caribbean, and in Cuba, but rather rare from Charleston northward. The only authority for its occurrence in New York waters till recently has been Cuvier and Valenciennes, who claimed to have a specimen from New York. De Kay did not regard it as a member of the fish fauna. In 1899, however, W. I. De Nyse secured several fine examples at Gravesend beach, L. I., and one of these, 8 inches long, is now in the U. S. National Museum, where it is numbered 49219.

The fish grows to the length of 10 inches. It has no value as food, but is a beautiful species.

Genus TRACHINOTUS Lacépède

Body compressed, moderately elevated, the general outline ovate; caudal peduncle short and rather slender; abdomen not trenchant, shorter than the anal fin; head moderately compressed, very blunt, the snout abruptly truncate; mouth nearly horizontal the maxillary reaching the middle of the eye; premaxillaries protractile; maxillary without distinct supplemental bone; jaws, vomer and palatines with bands of villiform teeth, which are deciduous with age; preopercle entire in the adult; gill rakers short; gill membranes considerably united; spinous dorsal represented by six rather low spines, which are connected by membrane in the young but are free in the adult. In old specimens the spines appear small on account of encroachments of the flesh, and ultimately often disappear. Second dorsal long, elevated in front; anal opposite to it and similar in form and size; two stout, nearly free spines in front of anal, and one connected with the fin, these often disappearing with age; scales small, smooth; lateral line unarmed, little arched; no caudal keel.

When extremely young, the preoperculum is armed at the angle with three large spines, and smaller ones above and below. The spinous dorsal is developed as a perfect fin, and teeth are present on the jaws and palatine arch. In this stage the species has never been described by previous naturalists, and consequently has received no name, as the corresponding stage of Naucrates (Nauclerus) has. At an early period the preopercular spines are absorbed into the substance of the preoperculum and disappear. The spinous dorsal and the teeth are still retained. In this condition it remains for some time, the spinous dorsal, however, gradually losing its relative size, while the soft vertical fins increase. In this stage the species belongs to the genus Doliodon of Girard. At a later period the membrane connecting the dorsal spines has become obsolete, and the species then represents the genus Trachynotus, as understood by Cuvier and Valenciennes, and others. Finally, in old age, the teeth of the jaws, palate, and pharyngeal bones have fallen out, and the lobes of the dorsal, anal and caudal fins attain their greatest extension and become pointed. This final stage has been made known by Holbrook under the new generic name of Bothrolaemus. *Gill*[1]

The pseudobranchiae also disappear in old specimens. Some of the species of Trachinotus (carolinus etc.) are among the most highly valued of our food fishes. Most of them are however not of superior quality.

220 **Trachinotus falcatus** (Linnaeus)

Round Pompano; Ovate Pompano

Labrus falcatus Linnaeus, Syst. Nat. ed. X, I, 284, 1758, America.

The Spinous Dory Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, pl. VI, fig. 10, no description.

Zeus spinosus Mitchill, Am. Month. Mag. II, 246, Feb. 1818.

Trachinotus spinosus De Kay, N. Y. Fauna, Fishes, 117, pl. 19, fig. 53, 1842, New York harbor.

Trachinotus rhomboides Cuvier & Valenciennes, Hist. Nat. Poiss. VIII, 407, 1831.

Trachinotus fuscus Cuvier & Valenciennes, op. cit. VIII, 410, 1831, Brazil.

Trachynotus rhomboides Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 974, 1883; Bean, Bull. U. S. F. C. VII, 139, pl. III, fig. 5, 1888, young.

Trachynotus ovatus Günther, Cat. Fish. Brit. Mus. II, 481. 1860, (in part, not *Gasterosteus ovatus* of Linnaeus); Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 442, 1883; Bean, 19th Rep. Comm. Fish. N. Y. 255, pl. IX, fig. 12, 1890.

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[1]Phila. Acad. Nat. Sci. Proc. 1862, p. 440.

Trachinotus falcatus JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 941, 1896, pl. CXLVI, fig. 396, 1900; BEAN, Bull. Am. Mus. Nat. Hist. IX, 363, 1897; SMITH, Bull. U. S. F. C. XVII, 98, 1898.

Body broadly ovate, moderately compressed, profile very evenly convex from procumbent spine to level of upper edge of eye, where it descends almost vertically. The depth of the body is contained one and three fifths times in the length; the length of the head is contained three and three fourths times in that of the body. The vertical part is about one and one third times the eye; the length of snout nearly equal to eye; mouth nearly horizontal; maxillary reaching to vertical from middle of eye, its length two and two thirds in head; jaws without teeth in adult; dorsal spines short and thick, not connected by membrane in adult; ventrals short, their tips scarcely reaching half way to anterior anal spine, three in head; caudal widely forked; lobes about two and two thirds in length of body; dorsal and anal fins falcate; anterior rays reaching almost to posterior end of fins; in adults, dorsal lobe two and two thirds, anal lobe four and one half, in length of body. D. VI–I, 19; A. II–I, 18.

Color, bluish above, silvery below; the fins all bluish with lighter tips. In the young the coloration is different from that of the adult. An individual 1½ inches long, taken at Beesleys Point N. J. September 2, was mainly silvery when captured, but on being placed in a small aquarium almost instantly became dark brown, the dorsal and anal nearly black. On the ventrals, the anal spines, and the anterior tip of the anal fin was observed the usual vermilion, shading into orange. Five young, from 1 inch to 1¾ inches long, seined August 10 and 11 at Beesleys Point, exhibited, after immersion for several days in alcohol, the following colors: general color silvery, thickly sprinkled with dusky; sides wholly or partly suffused with pink; ventrals and tip of anterior anal rays orange; dorsal and anal dusky, with a narrow, pale marginal band; caudal milk white, the lower lobe faintly tinged with yellow; iris pink.

The ovate pompano inhabits the Atlantic coasts of tropical and temperate America; it is common in the West Indies; on our east coast it occurs north to Cape Cod and south to Brazil;

young individuals are very common about Cape Cod in summer, but no adults are seen. The young, from ½ to 1 inch long, appear in July, according to Dr Hugh M. Smith, and by September, when they disappear, they are two inches long. 13 young, averaging a little more than 2 inches in length, were obtained at Oak Island beach September 30.

The young of the round pompano are caught occasionally in summer in Gravesend bay. Early in September 1897 a small one was placed in a tank, where it lived and fed regularly till November. The low temperature of the water then killed it.

Mitchill gives a figure of the fish in the Transactions of the Literary and Philosophical Society of New York under the name spinous dory, but no description. De Kay calls it the spinous trachinote, and describes a specimen 3 inches long from the harbor of New York, taken in September 1817. He mentions it as a casual visitor from the south.

According to Dr Goode the species is known in the south as the shore pompano and in the Bermudas as the alewife. About the Bermudas this pompano is sometimes very abundant as, in 1875, a school containing 600 or 700 was seined on the south shore of the islands. The fish is highly esteemed there for table use.

The ovate pompano grows to the length of 15 inches and is generally prized for food.

221 **Trachinotus argenteus** Cuv. & Val.

Silvery Pompano

Trachinotus argenteus Cuvier & Valenciennes, Hist. Nat. Poiss. VIII, 413, 1831, New York and Rio Janeiro; De Kay, N. Y. Fauna, Fishes, 116, 1842; Bean, 19th Rep. Comm. Fish. N. Y. 255, pl. X, fig. 13, 1890; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 944, 1896; Smith, Bull. U. S. F. C. XVII, 98, 1898.

Trachinotus cupreus Cuvier & Valenciennes, Hist. Nat. Poiss. VIII, 414, 1831, Martinique.

Body oblong, compressed, deep, its greatest depth one half of total length without caudal, its thickness one fourth the depth and nearly one half the length of head; least depth of caudal peduncle one sixth of greatest depth; head short, two sevenths of total without caudal; eye small, circular, equal to snout, one

fourth as long as head; interorbital space convex, its width two fifths of length of head; maxilla reaches to below front of pupil; mandible reaching to below hind margin of orbit, its length equal to snout and eye combined; nostrils nearer to tip of snout than to eye, the anterior in a very short tube; teeth in villiform bands in both jaws, but more developed in the lower than in the upper; gill rakers short and stout, the longest about one half as long as eye. The origin of spinous dorsal is a little behind origin of ventral; the base of the fin equals postorbital length of head; the spines are all short, the third, and longest, two thirds as long as the eye. The antecedent spine of the soft dorsal is two thirds as long as the eye; the base of the fin equals three times the length of snout and eye combined; the longest ray is three times as long as the last ray and two thirds as long as the head. The middle caudal rays are three sevenths as long as the outer rays and one fourth longer than the head. The anal origin is under the sixth ray of the soft dorsal; the fin is preceded by two short isolated spines and a third closely connected with the first ray; the second of the antecedent spines is two thirds as long as the eye; the longest ray is two thirds as long as the head, and the last ray is about as long as the eye. The ventral origin is at a distance from tip of snout equal to one third of total length to end of middle caudal rays; the fin reaches to the vent and to below the fourth spine of the dorsal. The pectoral reaches to below the fifth spine of the dorsal, its length equal to length of head without the snout. D. V, I, 24; A. II, I. 22; V. I, 5; P. I, 17. Color silvery, with tips of anterior part of dorsal black and with blackish on the middle of the pectoral.

The measurements above are from an example nearly 6 inches long, no. 15085, U. S. National Museum, taken at Tompkinsville N. Y. Another example 3¼ inches long, no. 36036, U. S. National Museum, was collected at Blue Point cove, L. I. There are a number of additional examples in the U. S. National Museum from localities south of New York. The individual from Tompkinsville is almost exactly of the size of the type of the species

as recorded by Cuvier and Valenciennes and it agrees perfectly with the description of their T. argenteus. These authors had two specimens, one from New York and the other from Rio Janeiro, each 6 inches long. Dr Jordan, who has examined the types of the species, says one of them is a foot long, and that it has 25 dorsal rays and 23 rays in the anal.

There is still some question whether or not the argenteus of Cuvier and Valenciennes is the young of T. carolinus (Linnaeus). If we consider them identical we must assume that the very young, say from 1 inch to 2 inches long, are much more elongate than when they reach the length of 3 inches. I am unable to decide the question at present, but still incline to the belief that the silvery pompano is a distinct species. I have examined specimens fully 10 inches long which retain the depth of body characteristic of the young, that is, one half of total without caudal.

The example from Blue Point cove, Great South bay, was figured by the writer in the *19th report of the N. Y. Fish Commission*, pl. 10, fig. 13. De Kay, in his work on the fishes of New York, p. 116, translates the description of Cuvier and Valenciennes, not having obtained a specimen of the fish.

222 **Trachinotus carolinus** (Linnaeus)

Common Pompano

Gasterosteus carolinus Linnaeus, Syst. Nat. ed. XII, I. 490, 1766, Carolina.

Trachinotus pampanus Cuvier & Valenciennes, Hist. Nat. Poiss. VIII, 415, pl. 237, 1831, Brazil, Charleston.

Trachynotus pampanus Günther, Cat. Fish. Brit. Mus. II, 484, 1860.

Bothrolaemus pampanus Holbrook, Ichth. S. C. 81, pl. 11, fig. 2, 1856.

Lichia carolina De Kay, N. Y. Fauna, Fishes, 114, pl. 10, fig. 30, 1842, off Sandy Hook.

Trachynotus carolinus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 442, 1883; Bean, Bull. U. S. F. C. VII, 140, 1888, 19th Rep. Comm. Fish. N. Y. 254, pl. VIII, fig. 11, 1890.

Trachinotus carolinus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 944, 1896, pl. CXLVII, fig. 398, 1900; Bean, Bull. Am. Mus. Nat. Hist. IX, 363, 1897, 52d Ann. Rept. N. Y. State Mus. 104, 1900; Smith, Bull. U. S. F. C. XVII, 98, 1898.

Body oblong ovate, elevated, profile forming a gentle curve from the middle of the back to the snout, where it descends

abruptly. The depth of the body is contained two and one third times in its length; the length of the head is contained four times in that of the body. Dorsal and anal falcate, their lobes reaching when depressed nearly to the middle of the fin; pectoral reaching to opposite the vent. Gill rakers short; slender in the young, becoming thick in the adult. Length 18 inches. D. VI–I, 25; A. II–I, 23.

Uniform bluish above, sides silvery, golden in the adult, without bands, fins plain silvery or dusky.

This fish has no other name on our east coast except the southern variation of pompeynose. In Great South bay the name butterfish is applied to it because it is confounded with the Poronotus triacanthus, to which the name properly belongs. Mitchill described it under the name thornbacked grunt, a name not now in use. The pompano ranges on our coast from Cape Cod to Florida, the adults rarely or never coming into northern waters, but the young are taken in variable numbers every year. At Woods Hole they sometimes occur in considerable numbers, and they have been taken in great abundance in Great Egg Harbor bay, but not recently. In Great South bay, in 1890, only a single young individual was secured at Oak Island beach on the last day of September. It occurs occasionally also on the Pacific coast. Dr De Kay, in 1842, mentioned it as an exceedingly rare species on the New York coast. His description was based on a specimen taken off Sandy Hook more than 20 years before. In 1898 young specimens were found in moderate numbers at Oak Island beach, Great South bay, September 14, and on the east side of Fire Island beach September 16. The young are summer and fall visitors in Gravesend bay. 22 individuals were placed in a tank in August 1897, and grew rapidly till the temperature of the water fell below 60° F in November. During this month all of them died.

The species reaches the length of 20 inches. It is one of the finest of our food fishes.

Family POMATOMIDAE

Bluefishes

Genus POMATOMUS Lacépède

Body oblong, compressed, covered with rather small scales, which are weakly ctenoid; caudal peduncle rather stout; head large, compressed; mouth large, oblique; premaxillaries protractile; maxillary not slipping under the preorbital, provided with a large supplemental bone, lower jaw projecting; bands of villiform teeth on vomer and palatines, those on the vomer forming a triangular patch; jaws each with a single series of very strong, compressed, unequal teeth, widely set, upper jaw with an inner series of small depressed teeth; villiform teeth on the base of the tongue; occipital keel strong; free edge of preopercle produced and serrated; gill membranes free from the isthmus, not united; branchiostegals seven; gills four, a slit behind the fourth; pseudobranchiae large; gill rakers slender, rather few; opercle ending in a flat point, cheek and opercles scaly; lateral line present, unarmed; dorsal fins two, the anterior of about eight weak, low spines connected by membrane and depressible in a groove; second dorsal long, similar to the elongate anal, both fins being densely scaly; fin rays slender; two very small, free anal spines, sometimes hidden in the skin; ventrals thoracic, I, 5; peduncle stout; pectorals rather short; caudal fin forked, the lobes broad; air bladder simple, with thin walls; pyloric caeca very numerous; vertebrae 10+14=24 as usual in Carangidae. A single species, found in nearly all warm seas.

223 **Pomatomus saltatrix** (Linnaeus)

Bluefish; Snap Mackerel; Snapper

Perca saltatrix LINNAEUS, Syst. Nat. ed. X, I, 293, 1758, Carolina.

Gasterosteus saltatrix LINNAEUS, op. cit. ed. XII, 491, 1766.

Scomber plumbeus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I. 424, pl. IV, fig. 1, 1815.

Temnodon saltator CUVIER & VALENCIENNES, Hist. Nat. Poiss. IX, 225, pl. 260, 1833; DE KAY, N. Y. Fauna, Fishes, 130, pl. 26, fig. 81, 1842; HOLBROOK, Ichth. S. C. 62, pl. 9, fig. 2, 1856; GÜNTHER, Cat. Fish. Brit. Mus. II, 479, 1860; STORER, Hist. Fish. Mass. 81, pl. XV, fig. 1, 1867.

Pomatomus saltator JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 448, 1883.

Pomatomus saltatrix Goode & Bean, Bull. Essex Inst. XI, 20, 1879; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 914, 1883; Bean, Bull. U. S. F. C. VII, 145, 1888; 19th Rep. Comm. Fish. N. Y. 269, pl. XX, fig. 24, 1890; Bull. Am. Mus. Nat. Hist. IX, 363, 1897; 52d Ann. Rept. N. Y. State Mus. 104, 1900; Smith, Bull. U. S. F. C. XVII, 98, 1898; Mearns, Bull. Am. Mus. Nat. Hist. X, 319, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 946, 1896, pl. CXLVIII, fig. 400, 1900; Eugene Smith, Proc. Linn. Soc. N. Y. 1897, 32, 1898.

Body robust, moderately compressed; belly compressed to a bluntish edge. The depth is contained four times in the length of the body. Head deep; top of head and a ridge on each side above the cheeks naked; cheeks much longer than opercles. The length of the head is contained three and one third times in the length of the body. Pectorals placed rather low, their length a little more than half that of the head. D. VIII-I. 25; A. II-I. 26; Lat. l. 95. Bluish or greenish, silvery below, a black blotch at the base of the pectoral.

Some of the many names applied to this widely distributed fish are the following: mackerel (New Jersey), horse mackerel (New York and Rhode Island), snapping mackerel (New England and New Jersey), skip mackerel (New York), snapper and blue snapper (New England), greenfish (Maryland, Virginia and North Carolina), salt-water jack (southern states), tailor (Chesapeake bay), whitefish (Hudson river). Bluefish is the name most extensively used on the coast and in the Gulf of Mexico.

The bluefish ranges on our coast from Maine to the Gulf of Mexico, and is believed to frequent warm seas of both continents. It has ranged farther to the northward this year than for many years before. We have heard of its capture in the vicinity of Mount Desert Me. On our coast and elsewhere its movements are erratic, and its abundance fluctuates greatly within certain periods; it disappears sometimes altogether for a term of years. The young, under about 1 inch in length, seem to be unknown. The spawning habits and localities have not been recorded. The smallest known examples were obtained at the surface offshore by the U. S. Fish Commission. The writer has seined individuals a little more than an inch long at Ocean City N. J. the last of August. The young ascend rivers into fresh water.

This is one of the most destructive of all fishes. It feeds ravenously, and, when gorged with food, continues to destroy its victims for the sake of gratifying its killing propensity. It follows the great schools of alewives, weakfish, mullets and other valuable food fishes along our coast in summer, and the young may be discovered in shallow bays and sounds pursuing the silversides, young herring, anchovies and other fishes smaller than themselves. According to De Kay bluefish were unknown on the New York coast till about 1810, when a few appeared. In 1815 Dr Mitchill wrote: "Young ones are taken plentifully with the hook at our wharves by the boys in August." The largest mentioned by Mitchill was 13 inches long, 3 inches deep and weighed about 14 ounces. The name bluefish was in use at the time of Mitchill's report.

De Kay noticed the gradual disappearance of the weakfish with the increasing abundance of bluefish.

The best known methods of taking bluefish are by trolling at the surface with a squid of metal or bone and by heaving and hauling in the surf near the mouths of streams into which alewives are running. Artificial minnows are also used with a light rod, when young bluefish are seen feeding near the surface. The most recent method in use by anglers is that of chumming in the manner usually employed in striped bass fishing. This method, which involves the use of rod and reel, was in use near the inlet at Fire Island early in October 1890. During the summer, in this bay, it was not an uncommon thing for anglers to catch 150 or 200 small bluefish with hook and line in a single day. The species is to be found in all parts of the bay visited by us. It was taken at the following localities: Blue Point cove, Oak Island and Fire Island. Large numbers of bluefish were caught late in September by means of gill nets set in the ocean near Blue Point Lifesaving station. A fisherman caught 450 at one time and 250 at another, the dates being Sep. 23 and 24, 1890. In August of that year bluefish drove immense schools of round herring (E t r u m e u s t e r e s) on the ocean beach, near the Lifesaving station. September 24, while walking along the beach of East Island, not far from the Blue Point station, in

a distance of half a mile, I saw 51 round herring lying on the beach, having been chased in a short time previously by bluefish. When the fishermen find the round herring on the shore, they know that bluefish are present. Small bluefish were caught in a trap at Islip Oct. 1, 1890. In the summer of 1898 young bluefish were abundant in all the waters visited in Peconic bay and Great South bay and were taken as late as October 16.

During the warm season they often run up the rivers, the young, called snappers, frequently into nearly fresh waters. (After Eugene Smith[1])

The bluefish is so active in its movements that it is difficult to keep it in captivity. As with the species of Caranx and Seriola, however, its longevity depends on range and temperature; in a large body of water, not colder than 60° in winter, it can be maintained easily.

Family RACHYCENTRIDAE

Sergeant Fishes

Genus RACHYCENTRON Kaup

Body elongate, fusiform, subcylindric, covered with very small, smooth, adherent scales; lateral line nearly parallel with the back; head rather broad, low, pikelike, the bones above appearing through the thin skin; mouth rather wide, nearly horizontal, the maxillary about reaching front of eye; both jaws, vomer, palatines and tongue with bands of short, sharp teeth, lower jaw longest; premaxillaries not protractile; preopercle unarmed; first dorsal represented by about eight low, stout, equal, free spines, each depressible in a groove; soft dorsal long and rather low, somewhat falcate, similar to and nearly opposite anal; two weak anal spines, one of them free from the fin; pectorals moderate, placed low; ventrals thoracic, I, 5; caudal fin strong, forked, on a moderate peduncle; no caudal keel; no finlets; gill rakers rather short, stout; no air bladder; branchiostegals seven; pyloric caeca branched; vertebrae 12+13=25. Probably only one species; a large, strong, voracious shore fish, found in all warm seas. Its relations are with the scombroid fishes, though not

[1]Linn. Soc. N. Y. Proc. 1897. no. 9, p. 32.

close to any of the other groups. The superficial resemblance to Echeneis, as Dr Gill has shown, is not connected with any intimate homology. (After Jordan and Evermann)

224 Rachycentron canadus (Linnaeus)

Crabeater; Cobia

Gasterosteus canadus Linnaeus, Syst. Nat. ed. XII, 491, 1766, Carolina.
Centronotus spinosus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 490, pl. III, fig. 9, 1815, New York.
Elacate atlantica Cuvier & Valenciennes, Hist. Nat. Poiss. VIII, 334, pl. 233, 1831, Brazil; De Kay, N. Y. Fauna, Fishes, 113, pl. 25, fig. 77, 1842.
Elacate nigra Günther, Cat. Fish. Brit. Mus. II, 375, 1860.
Elacate canada Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 418, 1883; Bean, Bull. U. S. F. C. VII, 144, pl. II, fig. 13, 1888, 19th Rep. Comm. Fish. N. Y. 270, pl. XX, fig. 25, 1890, (young), Great Egg Harbor Bay.
Rachycentron canadus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 948, 1896, pl. CXLVIII, fig. 401, 1900; Smith, Bull. U. S. F. C. XVII, 98, 1898.

Head much depressed. The length of the head is contained four and one fourth times in the length of the body; while the width of the body is contained five and two thirds times in its length. Mouth moderate, the short maxillary reaching front of orbit; pectorals broad and falcate; caudal deeply emarginate, the upper lobe slightly the longer; lateral line wavy and irregular, descending posteriorly. Length 5 feet. D. VIII–I, 26; A, II, 25. Color, olive brown; sides with a distinct broad dark band and a less distinct band above and below it; lower parts silvery.

The crabeater inhabits all warm seas, occasionally appearing on our Northern coast in summer and ranging northward to Massachusetts bay. Individuals are occasionally taken at Woods Hole Mass.

Dr Mitchill had a specimen of the crabeater which was caught in New York bay June 11, 1815. He found in its stomach 20 spotted sand crabs and several young flounders. The fish was eaten at his table, and pronounced one of the best he had ever tasted. This example was 31 inches long. Dr De Kay styles it the northern crabeater. The specimen described by him was captured in Boston harbor, and placed in a live car with other fish, chiefly porgies (Stenotomus chrysops), and it de-

stroyed and ate every fish in the car. Dr A. K. Fisher of Washington has found the young of the crabeater in the Hudson near Sing Sing. Though we have no specimens of the crabeater from Great South bay, there is scarcely a doubt of its occurrence in that body of water.

A young example, 3⅞ inches long, was caught at Somers Point N. J. near the club house, Aug. 2, 1887, by Capt. Richard Chamberlain. Ground color nearly black; a white stripe, about as wide as pupil, from upper angle of gill opening to caudal; another one, but narrower, begins at lower extremity of pectoral base, curves very slightly upward, fading out near the tail; upper caudal lobe with a narrow whitish margin along its upper surface, relieved by a trace of orange red at its base; lower caudal lobe with a narrow orange red margin; pectorals, ventrals, and caudal black; back fades to a dark green; belly grayish white; iris golden bronze. This species has not previously been recorded from Great Egg Harbor bay, and the young seems not to have been described.

Another example, 4 inches long, was seined in one of the thoroughfares in the bay August 23. This has the same markings as the first. The caudal when fully expanded, is rounded, the end truncate; there is no emargination as in the adult. A figure of the young is published in the bulletin of the U. S. Fish Commission, 1888, v. 7, pl. 2, fig. 13.

Family Coryphaenidae

Dolphins

Genus CORYPHAENA Linnaeus

Body elongate, compressed, covered with small cycloid scales; cleft of the mouth wide, oblique, the lower jaw projecting; cardiform teeth in the jaws and on the vomer and palatine bones, a patch of villiform teeth on the tongue, no teeth on the esophagus; opercular bones entire; skull with a crest which is more elevated in the adult than in the young; a single, many-rayed dorsal fin, not greatly elevated, extending from the nape nearly to the caudal fin; anal similar, but shorter, both without distinct spines; pectoral fins very short and small; ventrals well developed,

thoracic, I, 5, partly received into a groove in the abdomen; caudal fin widely forked; lateral line present; gill membranes free from the isthmus; branchiostegals seven; no pseudobranchiae; no air bladder; pyloric appendages very numerous; vertebrae about 30. A genus with probably only two species. Very large fishes, inhabiting the high seas in warm regions, noted for their brilliant and changeable colors. (After Jordan and Evermann)

225 Coryphaena hippurus Linnaeus

Common Dolphin

Coryphaena hippurus Linnaeus, Syst. Nat. ed. X, I, 261, 1758, open seas; Günther, Cat. Fish. Brit. Mus. II, 405, 1860; Cuvier & Valenciennes, Hist. Nat. Poiss. IX, 278, pl. 266, 1833; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 914, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 952, 1896, pl. CXLIX, fig. 402, 1900; Bean, Bull. Am. Mus. Nat. Hist. 363, 1897; Smith, Bull. U. S. F. C. XVII, 99, 1898.

Coryphaena hippuris Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 378, 1815.

Coryphaena sucurii Cuvier & Valenciennes, Hist. Nat. Poiss. IX, 302, 1833.

Coryphaena globiceps De Kay, N. Y. Fauna, Fishes, 132, pl. 10, fig. 29, 1842, off New York.

Coryphaena sucuri Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 155, 1883.

Body elongate, compressed, highest anteriorly, the greatest depth equal to length of head and to one fourth of total length without caudal; the greatest width about equal to postorbital length of head; least hight of caudal peduncle one fourth the length of head; maxilla reaching nearly to below end of eye; upper jaw equal to snout and eye combined; mandible reaching past hind margin of orbit. The profile of the snout becomes nearly vertical with age; the male has the forehead elevated, forming a crest which projects slightly beyond the upper jaw. Eye small, one half the length of snout, one sixth the length of head. The dorsal origin is nearly above the eye; the fin occupies the entire back, the longest spines (12th to 14th) equal postorbital length of head, the last spine two ninths as long as head. Caudal very deeply forked, the middle rays less than one sixth as long as the external rays, which are one third as long as the dorsal base. The anal begins under the 32d spine of the dorsal; its base is as long as the head and pectoral combined, its longest ray one third as long as the head, its last ray equal to eye, the

fin emarginate anteriorly. The ventral origin is directly under the pectoral base and under the 13th spine of the dorsal, its length one sixth of total length without caudal. The pectoral origin is below the 13th spine of the dorsal; the fin extends to below the 23d spine, its length equal to length of head without snout. D. 56–64; A. 25–30; V. I, 5; P. I, 19. Scales about 175; gill rakers 10, all below angle, the longest one half as long as the eye.

Colors in life brilliant, changing suddenly at death; greenish above, white or golden below, with bright blue spots, the largest on the back and head, forming bands on the snout; dorsal purplish blue, with pale longitudinal lines; other fins tinged with blue; caudal yellow; in spirits, silvery with blackish spots, smaller than the pupil, on the sides below the lateral line.

The dolphin inhabits all warm seas; it is common in the Gulf of Mexico, and its summer range includes Cape Cod. Large individuals are rare in Vineyard sound, but the young, from 2 to 12 inches long, are observed nearly every year in floating gulf weed, usually in July and August.

Mitchill mentions the species without referring to a particular specimen; but De Kay states that an individual 42 inches long was captured off the harbor of New York and presented to the Lyceum of Natural History. An example, 17 inches long and 2¾ inches deep, was caught off Sandy Hook late in August 1897 by a fisherman while trolling for bluefish.

The dolphin attains to the length of 6 feet. It is an excellent food fish.

226 Coryphaena equisetis Linnaeus

Small Dolphin

Coryphaena equisetis Linnaeus, Syst. Nat. ed. X, I, 261, 1758, high seas; Cuvier & Valenciennes, Hist. Nat. Poiss. IX, 297, pl. 267, 1833; Günther, Cat. Fish. Brit. Mus. II, 407, 1860; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 914, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 953, 1896.

Lampugus punctulatus Cuvier & Valenciennes, op. cit. IX, 327, 1833; De Kay, N. Y. Fauna, Fishes, 134, pl. 11, fig. 31, 1842.

Coryphaena punctulata Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 454, 1883.

This is said to be the Lampugus punctulatus of Cuvier and Valenciennes,[1] to which is ascribed the following characters. Hight of body contained nearly five times in its length; head five and one fourth times; depth of head five sevenths of its length; profile obliquely descending; pectorals one tenth of total length; ventrals one eighth; caudal lobes one fifth; 10 or 12 posterior rays of dorsal and anal dilated at their extremities and projecting beyond the connecting membrane. Color silvery, blackish on the back, with a few small black dots on the body. D. 51; A. 25; V. I, 5; P. 19.

The specimen described is 13 inches long. It was taken in the Atlantic at the equator.

De Kay has described a dolphin measuring 2 feet which was taken on a hook at the light-ship off the harbor of New York and which he supposed to be identical with the species just mentioned. The characters of the fish are given as follows. Length of head rather less than one eighth of total length; hight of body one eighth and of caudal peduncle at its lowest part one twentieth of total; eye large, its length contained four and four sevenths times in length of head and more than one diameter distant from tip of snout; dorsal fin beginning just behind the orbit, its last 10 or 12 rays somewhat elevated and projecting beyond the connecting membrane; pectoral origin under ninth dorsal spine; the fin one twelfth of total length including caudal; ventral length contained nine and three fifths times in total; anal origin nearly midway between posterior margin of orbit and base of caudal. Length 24 inches; head $3\frac{1}{5}$ inches; hight 3 inches. D. 53; A. 25; V. I, 5; P. 20.

Color sea green above the lateral line; silvery on the sides, with metallic reflections on the opercles; iris yellowish; dark reddish brown stripes across the head; a series of distant rounded spots along the base of the dorsal fin; a few scattering ones on the back part of the head, and confused series of similar spots on the sides below the lateral line; dorsal, pectorals and ventrals brown; anal and caudal fins light colored.

[1] Hist. Nat. Poiss. 1833. 9:327.

Jordan and Evermann, in Bulletin 47, U. S. National Museum, p. 953, state that the small dolphin is not recorded from the coast of the United States; but that it inhabits the open Atlantic and occurs rarely in the West Indies. De Kay, however, described a dolphin, above mentioned, which appears to agree with the published descriptions of the Coryphaena equisetis Linnaeus; and there is no reason to suppose that this pelagic species does not occasionally visit our shores. It is true that all the young dolphins from the New England and New York coasts examined by me belong to the larger species; but materials for study are scarce, and it is unwise to base a conclusion on insufficient investigation.

Family CENTROLOPHIDAE

Rudderfishes

Genus PALINURICHTHYS Bleeker

Body oblong, ovate, moderately compressed; profile very blunt and convex; mouth moderate; maxillary narrow, with a small supplemental bone; premaxillaries protractile, little movable; jaws nearly equal, each with about one series of small, slender teeth; no teeth on vomer or palatines; preoperculum, interoperculum, and subopercuhim finely serrated; gill rakers long; gill membranes separate, free from the isthmus; scales small, smooth, larger, thicker, and more adherent than in Stromateus; cheeks scaly; fins rather low; dorsal fin long, preceded by six to eight short, subequal, rather strong spines, the last ones connected by membrane, the others nearly free, all much lower than the soft rays; anal fin similar but shorter, preceded by three spines, which, like the dorsal spines, are nearly embedded in thick skin; vertical fins densely scaly toward their bases; caudal fin emarginate; caudal peduncle stout; ventral fins large, thoracic, I, 5; pectoral fins moderate, rounded, or falcate.

227 Palinurichthys perciformis (Mitchill)

Rudderfish; Black Pilot

Coryphaena perciformis MITCHILL, Am. Month. Mag. II, 244, Feb. 1818, New York Harbor.

Palinurus perciformis DE KAY, N. Y. Fauna, Fishes, 118, pl. 24, fig. 75, 1842; STORER, Hist. Fish. Mass. 74, pl. XIII, fig. 3, 1867.

Pammelas perciformis Günther, Cat. Fish. Brit. Mus. II, 485, 1860.
Lirus perciformis Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 452, 1883.
Palinurichthys perciformis Gill, Proc. Ac. Nat. Sci. Phila. 20, 1860; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 964, 1896; Goode & Bean, Bull. Essex Inst. XI, 16, 1879; Bean, Bull. Am. Mus. Nat. Hist. IX, 363, 1897; Smith, Bull. U. S. F. C. XVII, 99, 1898; Bean, 52d Ann. Rept. N. Y. State Mus. 104, 1900.

Body ovate, compressed, its depth two fifths of its length without the caudal; head short, blunt, its profile convex, its length two sevenths of the total without caudal; mouth moderate; maxillary narrow, reaching to opposite front of pupil; a small supplemental bone; eye with adipose eyelid; eye nearly equal to snout, two ninths as long as the head; top of head scaleless; cheeks scaly; jaws nearly equal, each with about one series of small, slender teeth, no teeth on vomer or palatines; gill rakers long; pectorals nearly as long as the head. D. VIII, 20; A. III, 16. Lateral line 75. Blackish green, everywhere dark, the belly almost similar and not silvery, sides often mottled with linear blotches. Length 1 foot.

The rudderfish is found on the Atlantic coast of North America from Maine to Cape Hatteras; usually off shore under drifting logs, boxes and other objects, but occasionally entering bays; one specimen was taken off Cornwall, having drifted across the Atlantic. The rudderfish is rare in Gravesend bay. One or two will usually appear there during the summer, but some years none are seen. The fish is common 2 or 3 miles off shore, and its capture with a dip net is not difficult. Numerous young and half grown examples were so taken off Southampton L. I. Aug. 3, 1898, and a fine adult was captured by Capt. George Yarrington in Clam Pond cove, Great South bay, Oct. 11, 1898.

Aug. 4, 1901, a school of rudderfish numbering about 50 was seen at the dock at Water Island, Great South bay, and one of them was obtained for the state museum.

Family STROMATEIDAE

Harvestfishes

Genus RHOMBUS Lacépède

Body ovate or suborbicular, strongly compressed, tapering into a slender caudal peduncle, which is not keeled or shielded;

head short, compressed, the profile obtuse; mouth small, terminal, the jaws subequal; premaxillaries not protractile; jaws each with a single series of weak teeth; scales very small, cycloid, silvery, loosely inserted, extending on the vertical fins; opercular bones entire; gill membranes separate, free from the isthmus; gill rakers moderate; lateral line continuous, concurrent with the back; dorsal fin long, more or less elevated in front, preceded by a few indistinct spines—usually one or more procumbent spines in front of dorsal and anal, each of these with a free point both anteriorly and posteriorly; anal fin similar to dorsal, or shorter, usually with three small spines; ventral fins wanting; a single small, sharp spine, attached to the pubic bone, occupying the place of the ventrals; pectorals long and narrow; caudal widely forked. Species few, mostly American. This genus differs from Stromateus chiefly in the prominence of the pelvic bone, which projects as a lamina beyond the skin. (After Jordan and Evermann)

Subgenus RHOMBUS

228 Rhombus paru (Linnaeus)

Harvestfish; Pappyfish

Stromateus paru Linnaeus, Syst. Nat. ed. X, I, 248, 1758, Jamaica; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 914, 1883.

Chaetodon alepidotus Linnaeus, Syst. Nat. ed. XII, 460, 1766, Charleston.

Stromateus alepidotus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 451, 1883.

Stromateus longipinnis Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 366, 1815, New York Bay.

Rhombus longipinnis Cuvier & Valenciennes, Hist. Nat. Poiss. IX, 401, pl. 274, 1833; De Kay, N. Y. Fauna, Fishes, 136, pl. 75, fig. 239, 1842.

Stromateus gardenii Günther, Cat. Fish. Brit. Mus. II, 399, 1860.

Rhombus paru Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 965, 1896, pl. CL, fig. 404, 1900; Bean, Bull. Am. Mus. Nat. Hist. IX, 364, 1897; Smith, Bull. U. S. F. C. XVII, 99, 1898.

Body ovate or suborbicular, strongly compressed, its greatest depth about three fourths of its length without the caudal; caudal peduncle short and slender, its least depth contained two and three fifths times in the length of the short head; mouth very small, oblique, the maxilla reaching to below front of eye; no pores along side of back; eye round, as long as the snout, and about one fourth as long as the head; profile of head very

obtuse; dorsal origin a little behind pectoral origin, base of dorsal almost equal to greatest depth of body, front of fin elevated, the longest ray as long as the pectoral, its length contained two and three fifths times in total length without caudal; anal base nearly as long as dorsal base, the longest anal ray much longer than the pectoral, the last dorsal and anal rays very short, scarcely two thirds as long as the eye, caudal deeply forked, its lobes equal, the longest rays as long as the pectoral. Scales small, thin and deciduous. D. IV to V, 45; A. II, 43. Scales about 90; vertebrae 15+15.

Color greenish above, golden yellow below. Mitchill gives the following description: "silvery, with tints of blue, green and iridescent; dusky on the head, and with inky patches on the belly towards the tail, which in certain lights appear beautifully red and purple; back bluish, with occasional clouds."

The harvestfish inhabits the West Indies and is found on our Atlantic coast from Cape Cod southward, ranging to Brazil. The young are frequently seen swimming beneath the Portuguese men-of-war.

De Kay had several specimens of the species, but found it less common than the short-finned harvestfish, R. triacanthus. At Charleston the fish is called rudderfish.

The species reaches a length of 8 inches. It is a valuable food fish. It is a summer visitor in Gravesend bay and is sometimes rare, but was formerly abundant there. It is not adapted to a captive life. At Woods Hole Mass. Dr Smith reports it as usually rare, but occasionally common. As a rule only three or four are taken in a season, but one year 300 or 400 were obtained. It occurs mostly in June and July, associated with the butterfish, R. triacanthus.

Subgenus PORONOTUS Gill

229 Rhombus triacanthus (Peck)

Butterfish; Harvestfish

Stromateus triacanthus PECK, Mem. Amer. Acad. II, part 2, 48, pl. 2, fig. 2, 1800, Piscataqua River, N. H.; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 451, 1883; GÜNTHER, Cat. Fish. Brit. Mus. II, 398, 1860.

Stromateus cryptosus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 365, pl. I, fig. 3, 1815. New York Bay.

Rhombus triacanthus DE KAY, N. Y. Fauna, Fishes, 137, pl. 26, fig. 80, 1842; STORER, Hist. Fish. Mass. pl. XV, fig. 4, 1867; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 967, 1896, pl. CL, fig. 405, 1900; BEAN, Bull. Am. Mus. Nat. Hist. IX, 363, 1897; SMITH, Bull. U. S. F. C. XVII, 99, 1898; BEAN, 52d Ann. Rept. N. Y. State Mus. 104, 1900.

Poronotus triacanthus GOODE & BEAN, Bull. Essex Inst. XI, 16, 1879; BEAN, Bull. U. S. F. C. VII, 140, 1888; 19th Rep. Comm. Fish. N. Y. 257, pl. XI, fig. 14, 1890.

Body oval, much compressed. The depth is contained two and one third times in the length. Dorsal and ventral outlines about equally curved. The length of the head is contained four times in that of the body. Snout very blunt, rounded in profile; mouth small, the maxillary not reaching the orbit; caudal peduncle very short; anterior rays of dorsal and anal little elevated; lateral line high, a series of conspicuous pores above it near the base of the dorsal; pectorals much longer than head; gill rakers rather long, two thirds the diameter of the eye, which is four in head. Length 10 inches. D. III, 45; A. III, 38. Bluish above, below silvery. Maine to Cape Hatteras; very abundant.

This is known as the dollarfish, harvestfish and lafayette. Mitchill called it the cryptous broad shiner, and De Kay described it under the name short-finned harvestfish. About Cape Cod it is the sheepshead and skipjack. In Connecticut it is called pumpkin seed and at Norfolk starfish.

The butterfish ranges from Maine to South Carolina, and is gradually replaced southward by the long-finned harvestfish, Rhombus parru. It is a summer visitor, associated with the mackerel. De Kay records it in New York bay July 1, and obtained it from fyke nets in New York harbor as late as October 12. We seined young examples at Blue Point Lifesaving station October 7, and others were secured September 30 at Oak Island beach. It is taken chiefly in pound nets, and has recently become a highly prized market fish. A few years ago it was little esteemed. The young are to be found in the summer months swimming at the surface in sheltered bays and fre-

quently under the shelter of the streamers of jellyfishes, where they are sometimes destroyed by the lasso cells of their host.

The harvestfish is present in Gravesend bay from April to November. Adults were taken at Southampton beach Aug. 1 and Aug. 3, 1898. The fish was not found in Great South bay during the summer and fall of 1898.

Group PERCOIDEA

Perchlike Fishes

Family CENTRARCHIDAE

Sunfishes

Genus POMOXYS Rafinesque

Body more or less elongate, strongly compressed, the snout projecting; mouth large, oblique; maxillary broad, with a well developed supplemental bone; teeth on vomer, palatines, entopterygoids and tongue; lower pharyngeals narrow, with sharp teeth; gill rakers long and slender, numerous; opercle emarginate; preopercle and preorbital finely serrated; scales large, feebly ctenoid; fins large, the anal larger than dorsal, of six spines and about 17 rays; dorsal with six to eight graduated spines, the spinous dorsal shorter than the soft part; caudal fin emarginate; pectorals rounded or obtusely pointed, with 15 or 16 rays, the upper longest; ventrals close together, each with a strong spine; branchiostegals seven; lateral line complete, the tubes straight and extending at least on the anterior half of the exposed surface of the scale; posterior processes of the premaxillaries not extending to the frontals; supraoccipital and parietal crest very strong, produced forward on the frontals to between the orbits; vertebrae 18+15=33.

230 Pomoxis annularis Rafinesque

Crappie

Pomoxis annularis RAFINESQUE, Jour. Ac. Nat. Sci. Phila. I, 417, pl. 17, fig. 1, 1818, Ohio River "Silver perch or Goldring"; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 464, 1883; BEAN, Fishes, Penna. 103, pl. 30, fig. 59, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 987, 1896, pl. CLIV, fig. 415, 1900.

Pomoxis nitidus GIRARD, Proc. Ac. Nat. Sci. Phila. 200, 1857 or, U. S. Pac. R. R. Exp. Fish. 6, pl. 2, figs. 5-8, 1858; GÜNTHER, Cat. Fish. Brit. Mus. I, 257, 1859.

In the crappie the depth of the body is two fifths of the total length, not including the tail. The length of the head is one third of the total. The mouth is oblique and larger than in the calico bass. The eye is about equal to the snout and nearly one fourth the length of the head. The upper jaw nearly one half the length of head; the maxilla reaches slightly beyond the middle of the eye. The longest rays of the dorsal and anal are about one half as long as the head. The pectoral is longer than the ventral and reaches only to above the origin of the anal. The ventral when laid back reaches to the vent. D. VI, 16; A. VI, 17. Scales 7-45 13. There is considerable variation in the number of spines and rays in the dorsal and anal fins.

Color clear silvery olive, the sides mottled with dark greenish blotches. On the upper part of the body are traces of narrow vertical bars. The dorsal and caudal are mottled, but the anal is usually uniform pale.

Among the many names which have been applied to the crappie are: bachelor, newlight, campbellite, *sac-a-lait*, bridge perch, strawberry perch, chinquapin perch, speckled perch, tin perch, goggle-eye, John demon, shad, white croppie and timber croppie.

In the lower Mississippi valley the crappie is one of the most common fishes. It is abundant also in the Ohio valley and occurs rarely in Lake Erie. The Ohio, Illinois and Mississippi rivers are particularly noted for an abundance of crappies, and the fish is very plentiful in Lake Pontchartrain, La., where it is one of the most highly prized of the smaller game fishes.

Dr Meek did not obtain the crappie in the Cayuga lake basin, but says it may be found in the canal near Montezuma, where the calico bass is said to be frequently taken.

The crappie is a very general favorite for pond culture, can be readily transported and under favorable conditions multiplies prodigiously. Its range has been very much extended by artificial means. The best distinguishing marks between the crappie and the calico bass are the more elongated form of the crappie, the presence of six spines in the dorsal and the nearly uniform whitish color of the anal. In the crappie the greatest

depth of the body is usually contained two and one half times in the total length without the tail, while in the calico bass the depth equals one half the length. These two species are so similar in size and habits that they are rarely distinguished except by ichthyologists.

The crappie grows to a length of about 1 foot and usually weighs 1 pound or less; but in a lake near St Louis an individual weighing 3 pounds has been recorded.

Crappie fishing usually begins in June and lasts till the coming of cold weather. Large numbers of these fish are collected near Quincy Ill. for distribution to other waters. At Peoria Ill. Prof. Forbes has taken them in March and April; he has found them also in Pistakee lake and at Ottawa. Cedar lake, Ind. and King's lake, Mo. are celebrated crappie waters. Near Covington Ky. in private ponds belonging to Joseph Schlosser there are myriads of crappies as well as other game fishes.

Prof. S. A. Forbes has studied the feeding habits of the crappie, and finds that the young live chiefly on entomostraca and small insect larvae. The adults subsist on the same food when obtainable, but in times of scarcity they feed to some extent on other fishes. Small minnows and darters have been found in their stomachs. In the autumn Prof. Forbes has found a larger percentage of small fishes, sometimes constituting nearly two fifths of their food. The hellgramite is eaten by the crappie. In cold weather it does not consume one fourth the amount of food which it takes in the early spring. The crappie prefers still waters, thriving even in warm and muddy water, and has been taken in large numbers in midsummer at depths of only a few feet; in cold weather it retires to deeper water, becomes rather sluggish and takes little food. Dr Henshall states that the crappie is found about dams and in deep still parts of streams and ponds, specially about logs, brush and drift.

The crappie is a very free biter and can be caught readily with minnows or worms. Spoon bait has been successfully used in trolling for this species. It is recorded that two men have

taken a thousand crappies in three days' fishing with hook and line. As the fish is gregarious, congregating in large schools, and fearless, it can be taken in the immense numbers given. The best bait for crappie is a small shiner. It rises well also to the artificial fly. As a food fish this is one of the best in our inland waters, and its adaptability for life in artificial ponds should make it a favorite with fish culturists.

231 Pomoxis sparoides (Lacépède)

Calico Bass; Strawberry Bass

Labrus sparoides LACÉPÈDE, Hist. Nat. Poiss. III, 517, 1802, South Carolina.

Cantharus nigromaculatus LE SUEUR, in CUVIER & VALENCIENNES, Hist. Nat. Poiss. III, 88, 1829, Wabash River.

Centrarchus hexacanthus CUVIER & VALENCIENNES, Hist. Nat. Poiss. VII, 458, 1831, Charleston, S. C.; KIRTLAND, Bost. Jour. Nat. Hist. III, 480, pl. XXIX, fig. 2, 1841; GÜNTHER, Cat. Fish. Brit. Mus. I, 257, 1859.

Pomotis hexacanthus HOLBROOK, Ichth. S. C. 15, pl. 3, fig. 1, 1856.

Pomoxys sparoides JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 465, 1883; BEAN, Fishes Penna. 102, color pl. 9, 1893.

Pomoxis sparoides MEEK, Ann. N. Y. Ac. Sci. IV, 312, 1888; BOLLMAN, Rep't. U. S. F. C. XVI, 559, pl. 68, fig. 2, 1892; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 987, 1896, pl. CLIV, fig. 416, 1900; EUGENE SMITH, Proc. Linn. Soc. N. Y. for 1897, 33, 1898.

The calico bass has the depth about one half the length, not including the tail, the head about one third. The mouth is very oblique and smaller than in the crappie. The eye is as long as the snout and one fourth as long as the head. The maxilla reaches to slightly beyond the middle of the eye. The dorsal and anal fins are very high; the longest rays are half as long as the head. The pectoral is as long as the ventral, slightly shorter than the longest ray of the dorsal. The ventral reaches to third anal spine. D. VII, 15; A. VI, 17–18. Scales 7–42–15. The sides are olivaceous with silvery reflections and mottled with pale green. The dorsal, anal and caudal show pale spots surrounded by green reticulations.

The calico bass, on account of its wide distribution and variability, has received a profusion of names. Many of these are variations of the term bass. It is known, for example, as strawberry bass, grass bass, lake bass, Lake Erie bass, bank lake bass, silver bass, and big-fin bass. Other names for the species are

strawberry perch, chinquapin perch, goggle-eye perch, silver perch and sand perch. Still other names of local application are barfish, bitter head, tinmouth, *sac-a-lait*, lamplighter, razorback, goggle-eye, black croppie and lake croppie. The species is mentioned in the fish laws of Pennsylvania under the name of Lake Erie bass or grass bass.

The distribution of the calico bass is naturally extensive, and it has been still further increased by artificial introduction. The fish has been carried to France, and examples measuring about 8 inches in length were recorded there several years ago. There is, however, some confusion in that country between the calico bass and the common sunfish, and there is no doubt that some of the latter species have been introduced into Germany under the mistaken belief that they were calico bass.

This bass is indigenous east of the Alleghanies from New Jersey southward to Georgia. It abounds in the Great lakes region, Mississippi valley south to Louisiana, most common northward and occurs in the Missouri. In the Ohio valley it was rather uncommon till its introduction in large numbers. It was introduced into the Susquehanna river by the Pennsylvania Fish Commission, and has become acclimatized there; also into the Monongahela, the Lehigh, and other waters.

Fishermen of the region about Montezuma informed Dr Meek that the fish is frequently taken from the canal near that place, where it is known as calico bass. The U. S. Fish Commission obtained two examples in Long pond, at Charlotte N. Y. Aug. 17, 1894.

This bass grows to a length of about 1 foot and a maximum weight of nearly 3 pounds, but the average weight is about 1 pound. It spawns in the spring, and the close season in some states extends to June 1. Gravid females were caught near Havre de Grace Md. in May. These were taken in the Susquehanna and Tidewater canal, where the species is becoming rather abundant. The food of the calico bass consists of worms, small crustaceans and fishes. Though a native of deep, sluggish waters of western rivers and lakes, it readily adapts itself to

cold, rapid streams and thrives even in small brooks. The species is suitable also for pond life and may be kept in small areas of water provided they have sufficient depth. It does not prey on other fishes, and its numerous stiff spines protect it from larger predaceous species. It swims in large schools and is often found in comparatively shoal water. The nest-building habits have been described by Duclos from observations made at Versailles, France. This writer unfortunately had under observation both the calico bass and the common sunfish, and his statements need confirmation. The game qualities of this bass are noteworthy. It is a free, vigorous biter, its endurance is rather remarkable considering its size; as a food fish the species is highly prized, and its increase in eastern rivers is greatly to be desired.

Genus ACANTHARCHUS Gill

Body oblong, robust, not much compressed or elevated; mouth not very large, the broad maxillary with a well developed supplemental bone; lower jaw projecting; teeth on vomer, palatines, pterygoids and tongue, lingual teeth in a single patch, pharyngeal teeth sharp; gill rakers few, rather long and strong; opercle emarginate; preopercle entire; scales cycloid, large; lateral line complete; dorsal spines usually 11; anal spines five; caudal fin rounded behind. Close to Ambloplites, differing chiefly in the rounded caudal. One species known.

232 Acantharchus pomotis (Baird)

Mud Sunfish

Centrarchus pomitis Baird, Ninth Smithson. Rep't. 325, 1855, New Jersey, New York; Günther, Cat. Fish. Brit. Mus. I. 256, 1859.

Acantharchus pomotis Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 469, 1883; Bean, Bull. U. S. F. C. VII. 143, 1888; Fishes Penna. 107, 1893; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 989, 1896, pl. CLV, fig. 418, 1900; Eugene Smith, Proc. Linn. Soc. N. Y. for 1897, 34, 1898.

The mud sunfish has an oblong and moderately elongate body, its greatest depth, near the vent, two fifths of the total length without the caudal. The greatest thickness is a little less than one half the depth. The caudal peduncle is short and deep, its least depth two fifths of greatest depth of body. The head

is moderately large, rather more than one third of total length without the caudal, its width equal to the length of its postorbital part. The snout is very short and obtuse, its length about one half that of the eye. The eye is placed high, its diameter contained three and two thirds times in the length of the head. The interorbital space is slightly convex, its width three fourths the length of the eye. The mouth is large, the maxilla broadly expanded behind and reaching nearly to below the hind margin of the eye. A well developed supplemental maxillary bone, two thirds as long as the eye. Six rows of scales on the cheeks. The operculum ends in two thin, flat points, between which there is a black spot, about two fifths as long as the eye. Gill rakers short and few, five developed on the first arch, the longest two fifths as long as the eye. The spinous dorsal begins over the fifth scale of the lateral line; its base is as long as the head without the snout. The first spine is very short, one half as long as the eye; the spines increase very gradually in length to the last, which is as long as the eye and snout combined. The soft dorsal base is two thirds as long as that of the spinous dorsal; its rays are longer than the spines, the longest (fourth to sixth) about one half as long as the head. The anal begins under 18th scale of the lateral line; the first spine one half as long as the eye; the spines increase in length to the last, which is one third as long as the head; the rays are long, the longest (fourth) equal to postorbital length of head. The ventral reaches to the vent. The pectoral reaches to below the 15th scale of the lateral line. The caudal is rounded, its middle rays five sevenths as long as the head. The lateral line is complete and runs parallel to the dorsal outline. D. XII, 11; A. VI, 10; V. I, 5; P. 14. Scales 6–43–12. In spirits the color is dark brown; two or three dusky stripes on the sides below the lateral line; a dark shade around the nape extending backward behind the eye; two dark stripes across the cheeks and operculum; a dark opercular flap as described above; the fins unspotted. In life the fish is dark green. The example described, no. 17844 U. S. National Museum, from New Jersey,

is 4¼ inches long. It has more dorsal and anal spines than are usually present in this sunfish.

The colors of living specimens were described by Prof. Baird as follows:

Dark greenish olive, with three or four irregular longitudinal bands of dull greenish yellow, and occasionally cloudy spots of golden green. Sides of the head of this color, with three indistinct bands of dark olive. Iris purplish brown; cornea olive green. Fins quite uniform, very dark greenish olive, with darker margins, except the pectorals, which are light olivaceous, and the ventrals, the spinous rays of which are uncolored. Some specimens may be better described as dark golden green, with longitudinal bands of dark olive, broken up by cloudings of greenish.

Baird called it the bass sunfish because of its resemblance in shape to some of the basses. The species ranges from New York to North Carolina in sluggish streams near the coast. Baird collected it in Rockland county, N. Y. Eugene Smith took it in the upper Hackensack valley. Baird found it not rare in Cedar Swamp creek, near Beesleys Point N. J. in 1854; and the writer obtained a single individual in Gravelly run, not far from that locality, in 1887, associated with the pirate perch, striped mud minnow, barred killifish and young pickerel.

The mud sunfish reaches a length of 6 inches. It prefers muddy water and may even lie embedded in mud. Eugene Smith says it is shy, seclusive and nocturnal in its habits.

Genus AMBLOPLITES Rafinesque

Body oblong, moderately elevated, compressed; mouth large, the broad maxillary with a well developed supplemental bone, lower jaw projecting; teeth on vomer, palatines, tongue, entopterygoids and ectopterygoids, lingual teeth in a single patch, pharyngeal teeth sharp; branchiostegals six; opercle ending in two flat points; preopercle serrate at its angle; other membrane bones chiefly entire; gill rakers rather long and strong, dentate, less than 10 in number, developed only on the lower part of the arch; scales large, somewhat ctenoid; lateral line complete, the tubes occupying at least the anterior half of the surface of the scale; dorsal fin much more developed than the anal fin, with 10

or 11 rather low spines; anal spines normally six; pectorals obtusely pointed with 14 or 15 rays, the upper longest; caudal fin emarginate.

233 Ambloplites rupestris (Rafinesque)

Rock Bass; Redeye

Bodianus rupestris Rafinesque, Am. Month. Mag. II, 120, Dec. 1817, Lakes of New York, Vermont & Canada.

Cichla aenea Le Sueur, Jour. Ac. Nat. Sci. Phila. II, 214, pl. 12, 1822, Lake Ontario.

Centrarchus aeneus Cuvier & Valenciennes, Hist. Nat. Poiss. III, 84, 1829; De Kay, N. Y. Fauna, Fishes, 27, pl. 2, fig. 4, 1842, Lake Champlain, Great Lakes, streams of western New York, Hudson River; Storer, Syn. Fish. N. A. 37, 1846.

Ambloplites rupestris Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 466, 1883; Bean, Fishes Penna. 105, color pl. 10, 1893; Evermann & Kendall, Rept. U. S. F. C. for 1894; 600, 1896; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 990, 1896, pl. CLVI, figs. 419, A, B, C; Meek, Ann. N. Y. Ac. Sci. IV, 313, 1898; Eugene Smith, Proc. Linn. Soc. N. Y. for 1897, 33, 1898; Mearns, Bull. Am. Mus. Nat. Hist. X, 319, 1898; Bean, 52 Ann. Rept. N. Y. State Mus. 104, 1900.

The rock bass has a robust oblong body; its depth is contained two and one third times in the total length without caudal, the head two and four fifths in this same length. The caudal peduncle is stout, almost as deep as long. The dorsal profile is rather steep; strongly concave over eye. The eye is large, about one fourth the length of head, equal to snout. The mouth is large, the maxillary reaching to vertical from posterior end of pupil. The heavy lower jaw projects slightly. The vomer, palatines, tongue and pterygoid bones all toothed; the teeth on the tongue in a single patch. The pharyngeal teeth are sharp. The opercle ends in two flat points; preopercle serrated at its angle. Gill rakers long and strong, less than 10 in number; six branchiostegals; scales large, those on the cheeks in about eight rows; caudal rather deeply emarginate. The dorsal base is about one and one half times as long as that of the anal. The spines of both fins are stout and rather short. The first spine of the dorsal is over the seventh scale of the lateral line, and the last spine is over the 25th scale. The first soft ray is over the 26th scale, and the last ray over the 35th. The anal origin is under the middle of the spinous dorsal, and

the last anal ray is opposite the last dorsal ray. First dorsal spine shortest, one half the length of longest spine, which is about three fifths as long as the longest ray. The spines and rays of the anal are in about the same proportion to each other as those of the dorsal, the first spine being the shortest and the longest about three fifths as long as the longest anal ray. The soft parts of the dorsal and anal are high and rounded. The pectoral is rather short and broad. The ventral long and slender, directly under base of pectoral. The lateral line is complete, placed high on body and follows the contour of the back. D. XI, 11; A. VI, 11. Scales 5 46 11.

Color olive green with a brassy tinge and much dark mottling; the young are pale or yellowish, irregularly barred and blotched with black; adults with a dark spot at the base of each scale, these spots forming interrupted black stripes; a dark spot on the opercle; soft dorsal, anal, and caudal fins with dark mottlings; iris golden overlaid with crimson.

The rock bass is known under a variety of names. Among them are the following: redeye, red-eyed perch, goggle-eye and lake bass. It is found in Lower Canada, Vermont and throughout the Great lakes region, west to Manitoba, and it is native in Minnesota and Dakota; southward it ranges through the Mississippi valley to Texas. In the Ohio valley it is very common, while in the Middle Atlantic states, east of the Alleghanies, it has probably been introduced. Its existence in the Susquehanna has been known for many years. Whether it is indigenous in Pennsylvania waters is uncertain. It has been introduced into some parts of Virginia, while in other portions of that state it is native. It is indigenous in North Carolina. Its distribution in Pennsylvania has been greatly extended by artificial introduction, and it is now well established in the Delaware, specially in its upper waters. De Kay records it from Lake Champlain, the Great lakes and the larger streams in the western counties of New York. Meek says it is a very common and well known species in the Cayuga lake basin. In the Passaic river and other waters it is an introduced species. Evermann

and Bean obtained a specimen in Scioto creek, Coopersville N. Y. July 19, 1894. In the Lake Ontario region the U. S. Fish Commission collectors secured it at the following localities in New York state in 1894 and previous years.

Marsh creek, near Pointbreeze.
Mouth Little Salmon creek
Chaumont river
Guffon creek, Chaumont
Mill creek, Sacketts Harbor
Black creek, tributary of Oswego river, Scriba Corner
Sandy creek, North Hamlin
Mouth Salmon river, Selkirk
Cape Vincent
Little Stony brook, Henderson bay
Long pond, Charlotte
Cemetery creek, Watertown
Great Sodus bay
Grenadier island, Lake Ontario
Salt brook, 1½ miles above Nine Mile point
Nine Mile point, Webster

Under circumstances favorable as to water and food supply the rock bass grows to a length of 14 inches and a weight of 2 pounds. It increases in depth and thickness with age. The largest example we have examined is one of 2 pounds weight, length 14 inches, from the James river, Va., taken near Richmond. Dr William Overton reports that rock bass weighing 3¾ pounds have been taken in his vicinity at Stony creek, Va.

In February and March this fish frequents the mouths of small streams, and in summer it seeks shady places under high banks or projecting rocks. The species is gregarious, going in large schools. It thrives where there is not much current and is very well adapted for culture in artificial ponds. It is as common in lakes and ponds as in the streams. Sluggish, pure dark water suits it best.

The fishing season begins in June and lasts till the approach of cold weather. The rock bass feeds on worms, crustaceans

and larvae of insects early in the season; later its food consists of minnows and crawfish. The young feed on insects and their larvae. The spawning season is May and June, and gravelly shoals are resorted to for depositing the eggs.

The rock bass bites very freely and is a fair game fish and excellent for the table. It fights vigorously, but its endurance is not great. Suitable baits are white grubs, crickets, grasshoppers, crawfish and small minnows. Common earthworms are also successfully used.

Genus CHAENOBRYTTUS Gill

This genus has the general form and dentition of Ambloplites, with the convex opercle, 10 dorsal and three anal spines of Lepomis. Preopercle entire; branchiostegals six; caudal fin emarginate; scales weakly ctenoid; vertebrae 13+16=29; posterior processes of the premaxillaries extending nearly to the frontals; frontals posteriorly with a transverse ridge connecting the parietal and supraoccipital crest, which are very strong.

234 Chaenobryttus gulosus (Cuv. & Val.)

Warmouth; Goggle-eye

Pomotis gulosus CUVIER & VALENCIENNES, Hist. Nat. Poiss. III, 498, 1829, Lake Pontchartrain and lagoons about New Orleans.

Centrarchus viridis CUVIER & VALENCIENNES, op. cit. VII, 460, 1831, Charleston, S. C.

Centrarchus gulosus CUVIER & VALENCIENNES, op. cit. VII, 459, 1831; GÜNTHER, Cat. Fish. Brit. Mus. I, 258, 1859.

Chaenobryttus antistius MCKAY, Proc. U. S. Nat. Mus. 88, 1881, Lake Michigan; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 467, 1883.

Chaenobryttus gulosus JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 468, 1883; BOLLMAN, Rept. U. S. F. C. XVI, 562, pl. 69, fig. 3, 1892; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 992, 1896, pl. CLVII, fig. 421, 1900.

The body of the warmouth is heavy and deep, more elongate than in Lepomis, its greatest depth contained from two to two and one half times in total length without caudal; head rather long, its length contained from two and one fifth to two and two thirds times in the total without caudal; eye large, about one fourth as long as the head, and about equal to the snout; mouth large, the maxillary reaching to below hind margin of eye; gill rakers eight or nine besides some rudiments; oper-

cular spot about as large as the eye. The dorsal begins farther back than the pectoral, its spines low, the longest equal to distance from tip of snout to middle of pupil; pectoral short, not reaching to anal; ventrals nearly reaching vent, the spine about one half the distance from origin of ventral to vent. D. X, 9 to 10; A. III, 8 to 9. Scales 6–40 to 46 11 to 12; pores 37 to 42; 6 to 8 rows on cheek.

Color in life clear olive green clouded with darker, usually without red or blue; a dusky spot on each scale more or less distinct; vertical fins mottled with dusky; a faint spot on last rays of dorsal bordered by paler; three oblique dusky bars radiating from eye; belly yellowish.

The warmouth inhabits the eastern United States from the Great lakes to South Carolina and Texas, ranging west to Kansas and Iowa. It occurs chiefly west or south of the Alleghanies. The fish reaches a length of 10 inches and is a food species of some importance. It is extremely voracious and, consequently, a favorite for angling. In form and color it varies greatly.

Genus ENNEACANTHUS Gill

Body rather short and deep, compressed; mouth small; the supplemental maxillary bone well developed; teeth on vomer and palatines, none on the tongue; opercle ending behind in two flat points, with a dermal border; preopercle entire; scales rather large, the lateral line sometimes interrupted; gill rakers short, nine or 10 below angle of arch; dorsal fin continuous, normally with nine spines; anal fin smaller than the dorsal, with three spines; caudal fin convex behind; branchiostegals six. Species of small size and bright coloration, intermediate between Lepomis and Centrarchus. Abnormal variations in the number of dorsal and anal spines have given rise to the nominal genera Hemioplites and Copelandia.

235 Enneacanthus obesus (Baird)

Banded Sunfish

Pomotis obesus BAIRD, 9th Ann. Rept. Smith. Inst. 324, 1855, Beesleys Point, N. J.

Bryttus fasciatus HOLBROOK, Jour. Ac. Nat. Sci. Phila. 51, pl. 5, fig. 3, 1855, St John's River, Fla.; GUNTHER, Cat. Fish. Brit. Mus. I, 260, 1859.

Pomotis guttatus MORRIS, Proc. Ac. Nat. Sci. Phila. 3, 1859, Delaware River Philadelphia, Pa.

Enneacanthus obesus JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 470, 1883; BEAN, Fishes Penna. 108, 1893; EUGENE SMITH, Proc. Linn. Soc. 1897, 34, 1898, Hackensack Valley, N. Y.

The body of the banded sunfish is elliptic in form, its depth more than one half the total length without caudal, its thickness equal to two fifths of its depth. The caudal peduncle is short and stout, its least depth one third of greatest depth of body. The head is short, two fifths of total length without the caudal; the snout is very short and oblique, its length about two thirds of the diameter of the eye, which is one third as long as the head, and exceeds the width of the interorbital space. The mouth is oblique, moderate in size, the maxilla broadly expanded posteriorly and reaching to below the middle of the eye; a supplemental maxillary bone. A black opercular flap, two thirds as long as the eye. Scales on cheeks in four rows. Gill rakers short and spiny, 13 developed on the first arch, the longest scarcely one half as long as the eye. The first dorsal spine is over the pectoral base, minute, less than one half as long as the second, which is two thirds as long as the eye; the spines increase in size to the last, which is one half as long as the head; the fourth and longest soft ray is two thirds as long as the head. The ventral begins a little behind the pectoral base; the spine is two fifths as long as the head; the fin reaches to the second anal ray, its longest ray produced into a filament. The anal begins under the 13th scale of the lateral line; the base is two thirds as long as the head; the first spine is two thirds as long as the second, which is as long as the eye; the last spine is as long as the eye and snout combined. The anal rays increase in length to the fifth, which is as long as the head without the snout. The pectoral is below the median line and reaches to above the third anal spine. The caudal is rounded, the middle rays as long as the head without the snout. The lateral line is imperfect after the 17th to the 19th scale. D. IX, 11; A. III, 10; V. I, 5; P. 12. Scales 5–32–10. The type of the species, no. 6538, U. S. National Museum, from Beesleys Point N. J. is here described; it is $3\frac{3}{4}$ inches long.

The banded sunfish inhabits coastwise streams from Massachusetts to Florida. It occurs in southeastern Pennsylvania but is rare.

This species grows to a length of 3 inches. It is olive green in color with five to eight dark cross bars intermingled with golden or purplish spots. There are lines and spots also on the cheeks. The flap on the opercle contains a velvety black spot with a purple border. Below the eye is a dark bar. This is a beautiful little species, but has no economic importance.

In our vicinity it inhabits the entire Hackensack valley, preferring quiet, weedy places. For the aquarium it is the most desirable of all the sunfishes, as well on account of its hardiness as of its harmless nature. *Eugene Smith*

236 Enneacanthus gloriosus (Holbrook)

Blue-spotted Sunfish

Bryttus gloriosus Holbrook, Jour. Ac. Nat. Sci. Phila. 52, pl. 5, fig. 4, 1855, Cooper River, S. C.; Günther, Cat. Fish. Brit. Mus. I, 260, 1859.

Hemioplites simulans Cope, Jour. Ac. Nat. Sci. Phila. 218, 1868, Tuckahoe Creek, near Richmond, Va.

Enneacanthus simulans Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 470, 1883; Bean, Fishes Penna. 108, 1893, Trenton, N. J.

Enneacanthus eriarchus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 469, 1883.

Enneacanthus eriarchus Jordan & Gilbert, op. cit. 469, 1883.

Enneacanthus gloriosus Bollman, Rept. U. S. F. C. XVI, 564, 1892; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 993, 1896, pl. CLVIII, fig. 442, 1900; Mearns, Bull. Am. Mus. Nat. Hist. X, 319, 1898.

The blue-spotted sunfish has an elliptic body, its greatest depth one half of the total length without the caudal, its thickness nearly two fifths of its depth. Caudal peduncle short, its least depth one third of greatest depth of body. Head moderately large, three eighths of total length without the caudal; snout very short and oblique, two thirds as long as the eye, which is nearly one third as long as the head; mouth moderately large, oblique, the broadly expanded maxilla reaching nearly to below front of pupil; lower jaw slightly projecting; the operculum ends in two flat points, between which there is a dark spot two thirds as long as the eye and bordered below by a narrow pearly stripe; gill rakers short and stout, 11 developed on first

arch, the longest one third as long as the eye; four rows of scales on the cheeks. The spinous dorsal begins over the fourth scale of the lateral line; its base is two thirds as long as the head; the first spine is nearly one half as long as the eye; the spines gradually increase in length to the fourth, which is equal to those that follow it and to the length of the postorbital part of the head; the fifth, and longest, soft ray is as long as the head without the snout; the last soft ray is as long as the postorbital part of the head. The anal origin is under the 14th scale of the lateral line; the base of the anal fin is as long as the head without the snout; the first spine is one fourth as long as the head; the third and longest spine equals the postorbital part of the head in length; the third and fourth soft rays are longest, as long as the head without the snout. The ventral reaches to the second anal ray, its spine as long as the postorbital part of the head. The pectoral is placed below the median line of the body; it reaches to below the 14th scale of the lateral line. The caudal is rounded; its middle rays are three fourths as long as the head. The lateral line is usually complete, sometimes imperfect on one side. D. IX, 11; A. III, 10; V. I, 5; P. 11. Scales 4–31–10.

In spirits the color is brownish; about seven or eight rows of scales below the lateral line with pearly blotches forming interrupted stripes; a dark band under the eye; the dorsal, anal, and caudal profusely spotted with roundish, pearly spots. Young individuals are obscurely banded. In life the spots of the male are blue, and the fins are higher than in the female; the opercle bears a pearly blue spot. The specimens described, no. 20356, U. S. National Museum, are from Trenton N. J. The largest is 3 inches long.

The blue-spotted sunfish is found from New York to South Carolina. According to Cope, it is very common in southeastern Pennsylvania. Mearns obtained it only in Long pond, a sheet of deep water almost a mile in length, 4 miles west of Highland Falls N. Y. He discovered the species there more than 23 years ago, and reports it still common.

This is a small species, not much larger than the banded sunfish. It is a handsome fish, but has no importance for food.

Genus APOMOTIS Rafinesque

This genus is very close to Lepomis, from which it differs only in the development of the supplementary maxillary bone, which becomes rudimentary or wanting in the adult of Lepomis. The mouth is largest in the species in which this bone is best developed. Lower pharyngeals narrow, with acute teeth; gill rakers well developed, long and stiff; pectoral bluntish, shorter than head; scales moderate, 43 to 50. Species widely distributed in American waters, similar in habit to the species of Lepomis.

237 Apomotis cyanellus (Rafinesque)

Green Sunfish; Redeye

Lepomis cyanellus RAFINESQUE, Jour. de Phys. 420, 1819, Ohio River; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 473, 1883; BEAN, Fishes Penna. 110, pl. 31, fig. 61, 1893; MEEK, Ann. N. Y. Ac. Sci. IV, 313, 1888; EVERMANN & KENDALL, Bull. U. S. F. C. XII, 111, 1894.

Pomotis longulus BAIRD & GIRARD, Proc. Ac. Nat. Sci. Phila. 391, 1853, Otter Creek, Arkansas; Marcy's Expl. Red River, 245, pl. 12.

Bryttus longulus BAIRD & GIRARD, l. c. 25, 1854; GÜNTHER, Cat. Fish. Brit. Mus. I, 259, 1859.

Calliurus longulus GIRARD, U. S. Pacif. R. R. Exp. Fishes, 16, pl. 5, figs. 5-8, pl. 6, figs. 5-8, 1858; Rept. U. S. Mex. Bound. Surv. Ichth. 5, pl. IV, figs. 1-4, 1859.

Calliurus formosus GIRARD, Proc. Ac. Nat. Sci. Phila. 200, 1857, Arkansas; U. S. Pacif. R. R. Exp. Fishes, 14, pl. 5, figs. 1-4, 1858.

Apomotis cyanellus RAFINESQUE, Jour. de Phys. Paris, 420, 1819; BOULENGER, Cat. Fish. Brit. Mus. I, 21, 1896; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 996, 1896.

The green sunfish has an oblong body, its greatest depth, at the ventrals, equal to three sevenths of the total length without the caudal, and its thickness three eighths of its depth. The least depth of the caudal peduncle equals four fifths of its length, and about one third of greatest body depth. The head is one third of total length without the caudal, its width nearly one half its length. The snout is moderately pointed, and as long as the eye, which is two ninths as long as the head. The interorbital space is nearly flat, its width a little greater than the length of the eye. The nape is moderately arched. The

mouth is moderately large, the maxilla not widely expanded behind and reaching to below the front of the pupil. Supplemental maxillary bone well developed; seven rows of scales on the cheeks; gill rakers short and stiff, 11 developed on the first arch, the longest one third as long as the eye; a short, broad opercular flap, its width and length about equal and two thirds of length of eye. The spinous dorsal begins over the sixth scale of the lateral line, its base nearly equal in length to the head; the first spine is two thirds as long as the eye; the spines increase gradually in length to the seventh, which is two fifths as long as the spinous dorsal base and one half the length of the head without the snout; the 10th spine is nearly as long as the seventh; the seventh and longest soft ray is one half as long as the head; the last ray is one third as long as the head. The base of the soft dorsal is about two thirds as long as the spinous dorsal base. The anal begins under the 24th scale of the lateral line; the first spine is three fourths as long as the eye; the second is nearly twice, and the third two and one half times as long as the first; the length of the anal base equals one fifth of the total without the caudal; the fourth and longest anal ray is as long as the postorbital part of the head; the last ray is a little more than one half as long as the fourth. The caudal fin is emarginate, the middle rays three fourths as long as the external. The ventral reaches to the vent, its spine one half as long as the head, without the snout, its length one fifth of the total without the caudal. The pectoral reaches to below the 17th scale of the lateral line. The lateral line follows the outline of the back. D. X, 11; A. III, 10; V. I, 5; P. 13. Scales 7–47–14.

In spirits the color is pale brown, the fins paler. The opercular flap has a dark spot as described above. In life there is generally a black blotch on the hinder part of the dorsal and anal; the ground color is greenish with a brassy tinge on the sides, the lower parts yellowish; blue spots and gilt borders usually ornament the scales, and faint dark bands are often present. The dorsal, anal and caudal have blue or green mark-

ings, and the anal is margined in front with orange. The iris is red and the cheeks are striped with blue. The specimen described, no. 36313, U. S. National Museum, from the Sac river, Mo., is 7 inches long.

The blue-spotted sunfish, also known as the green sunfish and redeye, occurs from the Great lakes region, throughout the Ohio and Mississippi valleys south to Mexico. It does not occur in the Middle Atlantic states east of the Alleghanies. Dr Meek did not find this fish near Ithaca. A few specimens were taken near Montezuma N. Y. None of the collectors of the U. S. Fish Commission obtained it in the Lake Ontario region.

The species reaches a length of 7 inches, and is an extremely variable one. Prof. Cope refers to it as a good panfish and states that it is abundant in the Ohio basin. In the Ohio valley it is one of the characteristic fishes, inhabiting ponds and ascending small streams. It frequents deep holes and the shelter of overhanging roots.

Genus LEPOMIS Rafinesque

Body oblong or ovate, more or less compressed, the back in the adult somewhat elevated; mouth moderate or small, the jaws about equal; maxillary narrow, the supplemental bone reduced to a mere rudiment, or altogether wanting; teeth on vomer and usually on palatines, none on tongue or pterygoids, lower pharyngeals narrow, the teeth spherical or paved, all or nearly all sharp, few or none of them conical; gill rakers mostly short; preoperculum entire; operculum ending behind in a convex flap, black in color, which in some species becomes greatly developed with age; branchiostegals six; scales moderate; dorsal fin continuous, with 10 spines; anal with three spines; caudal fin emarginate; pectorals long or short; vertebrae usually 13-16 or 17—29 or 30. Coloration brilliant, but evanescent. A large genus, one of the most difficult in our fish fauna in which to distinguish species. The form of body, development of ear flap, and hight of spines vary with age and condition, while the general appearance and the numbers of fin rays and scales are essentially the same in all. Several at-

tempts have been made to subdivide the group, but the characters used, drawn from the pharyngeals, gill rakers, palatine teeth, and pectoral fins, are themselves subject to variation, changing or disappearing by degrees without marked gaps.

238 Lepomis auritus (Linnaeus)

Long-eared Sunfish

Labrus auritus Linnaeus, Syst. Nat. ed. X, I, 283, 1758, Philadelphia, Pa.
Labrus appendix Mitchill, Am. Month. Mag. II, 247, February, 1818.
Pomotis appendix De Kay, N. Y. Fauna, Fishes, 32, 1842, from Mitchill; Storer, Hist. Fish. Mass. 11, pl. III, fig. 4, 1867.
Pomotis rubricauda Storer, Bost. Jour. Nat. Hist. IV, 177, 1842, Concord, N. H.; Günther, Cat. Fish. Brit. Mus. I, 262, 1859.
Lepomis elongatus and *mystacalis* Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 475, 1883.
Lepomis auritus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 477, 1883; Bean, Fishes Penna. 113, pl. 31, fig. 63, 1893; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1001, 1896, pl. CLXIX, figs. 425, 425*a*, 1900; Mearns, Bull. Am. Mus. Nat. Hist. X, 319, 1898; Eugene Smith, Proc. Linn. Soc. N. Y. 1897, 34, 1898.

The long-eared sunfish has an oblong, moderately elongate body, its depth nearly one half of the length without the caudal and its thickness a little more than one third of its depth. The caudal peduncle is moderately short, its least depth three fourths of its length and one third of greatest depth of body. The head is rather large, its length without the flap one third of the total without caudal, its width one half of its length. The space between the eyes is convex, its width a little more than the length of the snout, which is two ninths as long as the head including the flap. The upper edge of the snout is oblique. The eye is one fourth as long as the head without the flap. The mouth is moderate in size, the maxilla not very broadly expanded behind and extending to below the front of the pupil. The scales on the cheeks are very small, in about eight rows. The opercular flap is long, narrow and pointed, its length equal to that of the snout and about twice its width. The gill rakers are short and stout, about 11 developed on the first arch, the longest one third as long as the eye. The spinous dorsal begins over the sixth scale of the lateral line; its base is two sevenths of total length without caudal; the first spine is two thirds as

long as the second, which is as long as the eye; the fourth (longest) is one and one half times as long as the eye; after the fourth the spines slightly decrease in length, the last being little longer than the eye; the fifth (longest) soft ray is as long as the base of the soft dorsal and equal to the snout and eye combined; the last soft ray is a little more than one half as long as the longest. The anal begins under the 21st scale of the lateral line; the length of its base equals that of the soft dorsal; the spines are short and stout, the first two thirds as long as the second and one half as long as the third, which is one and one half times as long as the eye; the fourth (longest) soft ray is as long as the base of the fin; the last ray is two thirds of this length. The caudal is emarginate, the middle rays two thirds as long as the outer. The ventral reaches beyond the vent, sometimes to the origin of the anal. The ventral spine is one half as long as the fin. The pectoral has a broad base and extends to below the 19th scale of the lateral line. D. X, 10; A. III, 9; V. I, 5; P. 14. Scales 7–43–13. The lateral line follows the curve of the back.

In spirits the color is pale brown; the fins somewhat paler; the ear flap black; a brownish streak in front of the eye and another horizontal one beneath it. In life the color is olivaceous; the belly, specially in breeding males, orange. The scales on the sides have reddish spots on a bluish ground. Dorsal, anal and caudal usually yellowish. The stripes on the head are bluish.

The specimen described, no. 33152, U. S. National Museum, from Bainbridge Pa. is $5\frac{1}{2}$ inches long.

The long-eared sunfish has a very extensive range and is known under many common names, among which are the following: bream, red-tailed bream, redhead bream, red-bellied bream, perch, sun perch, red-bellied perch and redbreast.

The species is common in streams east of the Alleghanies from Maine to Florida, and in tributaries of the Gulf of Mexico to Louisiana. In the southern states the typical long-eared sunfish is replaced by a variety with larger scales on the cheeks

and belly and a dusky blotch on the posterior part of the soft dorsal fin.

Mearns found this sunfish abundant in the Hudson and in Poplopen's creek, a tributary of the Hudson; he took it also in Highland lake. Eugene Smith reported it to be very common in the upper Passaic river, in the Great swamp and in the Bronx river.

The long-eared sunfish averages about 8 inches when adult and weighs about 1 pound. In the south the size and number of individuals are greatly increased. This fish feeds on worms, insect larvae, crustaceans, mollusks and small fishes. In the Susquehanna this is one of the most common of the sunfishes; in the Delaware also it is abundant, and reaches a large size. Though not important commercially, it is taken in large numbers on the hook and is an excellent food fish. It takes any kind of live bait very readily and furnishes good sport also with the artificial fly. In the Hudson Highlands region, according to Mearns, it is commonly sold in the markets; fishermen take it in fykes, and by angling, using dough, grasshoppers and angleworms for bait. He has caught it in the most rapid parts of Poplopen's creek when angling for brook trout.

239 Lepomis pallidus (Mitchill)

Bluegill: Blue Sunfish

Labrus pallidus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 407, 1815, near New York.

Pomotis incisor Cuvier & Valenciennes, Hist. Nat. Poiss. VII, 466, 1831, New Orleans; De Kay, N. Y. Fauna, Fishes, 33, 1842 (extralimital).

Pomotis gibbosus Cuvier & Valenciennes, op. cit. VII, 467, 1831, Charleston, S. C.

Pomotis speciosus Günther, Cat. Fish. Brit. Mus. I, 263, 1859.

Lepomis pallidus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 479, 1883; Meek, Ann. N. Y. Ac. Sci. IV, 313, 1888; Bean, Fishes Penna. 112, pl. 31, fig. 62, 1893; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1005, 1896, pl. CLX, fig. 427, 1900.

The blue sunfish has a deep, elliptic body, its greatest depth at the ventrals one half of the total length without the caudal; the thickness equals about one third of the depth. The caudal peduncle is short and deep, its least hight nearly one half the length of head. The head is one third of the total length with-

out the caudal; its width equals one half of its length. The snout is short, obtuse and oblique, less than the eye in length. The interorbital space is slightly convex, its width one third of the length of the head. The mouth is small, oblique, the maxilla not greatly expanded behind, reaching to below the front of the eye. The width of the preorbital equals one half the diameter of the eye. Scales on the cheeks in five rows. The gill rakers are short and stout, about 15 developed on the first arch, the longest little more than one fourth as long as the eye. No supplemental maxillary bone. No palatine teeth. The lower pharyngeal bone narrow, with teeth in only about four series, chiefly acute. The spinous dorsal begins over the fourth scale of the lateral line; the spines are stout, the first as long as the snout and one half as long as the fifth and longest; the spines following the fifth not much shorter; the first seven soft rays about equal in length and one half as long as the head; the last ray one third as long as the head. The base of the spinous dorsal is nearly as long as the head; the soft dorsal is two thirds as long as the spinous. The anal begins under the 20th scale of the lateral line; its base is as long as the head without the snout; the spines are short and heavy, the first five sixths as long as the eye, the second a little longer than the eye, and the third one half as long as the head without the snout; the longest rays are the fourth to the seventh, which are one half as long as the head. The caudal is notched, its middle rays three fourths as long as the outer. The ventral reaches almost to the anal, its spine being one half as long as the head without the snout. The pectoral is broad and reaches to below the 18th scale of the lateral line. The lateral line follows the curve of the back. D. X, 11; A. III, 10; V. I, 5; P. 13. Scales 7–41–15.

In spirits the color is pale brown, the scales with a pale margin; a large dark blotch on the hind part of the soft dorsal; a black opercular flap, its width and length about equal, shorter than the eye. The living fish varies with age from light green to dark green. The young have the sides silvery, tinged with

purple and with many vertical greenish bands, which are sometimes chainlike. The dark blotch of the soft dorsal is often indistinct in the young. In very old individuals the belly is often coppery red. The specimen described, no. 27845, U. S. National Museum, from Peoria Ill., is 7½ inches long.

The propriety of using Mitchill's name pallidus for the blue sunfish is extremely doubtful. His description can be much more readily referred to a species of Enneacanthus, and the locality "near New York" does not possess this sunfish among its native species.

The blue sunfish, blue bream, copper-nosed bream, or dollardee, is a very widely diffused species and varies greatly in size, color and length of the ear flap. It is found in the Great lakes and throughout the Mississippi valley to Mexico. East of the Alleghanies it ranges from New Jersey to Florida. In Pennsylvania it is abundant only in the western part of the state, including Lake Erie. Dr Abbott has recorded it from the Delaware river. Dr Meek says that it is found in the Cayuga lake basin in small numbers with the blue-spotted sunfish, Apomotis cyanellus, which he took near Montezuma.

The blue sunfish grows to a length of nearly 1 foot, and individuals weighing nearly 2 pounds are on record. Adults, however, average 8 inches in length, with a weight of less than 1 pound. The size of the individuals depends on the habitat. In large lakes and streams it grows to a greater size than in small bodies of water. In southern waters it attains to a larger size than in northern waters. It lives in ponds as well as in streams and thrives in warm waters. It is considered equal to the rock bass as a panfish and can very readily be taken by hook fishing.

Genus EUPOMOTIS Gill & Jordan

Very closely related to Lepomis, differing only in the blunter and more pavementlike teeth of the lower pharyngeal bones. These bones are, in typical species, broad and concave, specially in the adult. There is considerable variation among the species, and it is possible that this division can not be maintained. Most of the species have long pectoral fins, the sup-

plemental maxillary lost or very much reduced, and the opercular flap always with an orange patch on its lower posterior part. Gill rakers various, usually short. The retention of this genus is possibly justified by convenience, but neither the longer pectorals nor the blunt pharyngeals separate it sharply from L e p o m i s.

240 Eupomotis gibbosus (Linnaeus)

Sunfish; Pumpkin Seed

Perca gibbosa Linnaeus, Syst. Nat. ed. X, I, 292, 1758, Carolina.

Sparus aureus Walbaum, Artedi. Gen. Pisc. 290, 1792, lakes of New York.

Morone maculata Mitchill, Report in Part, 19, 1814.

Pomotis vulgaris Cuvier & Valenciennes, Hist. Nat. Poiss. III, 91, 1829, Lake Huron, New York, Virginia; and Carolina; De Kay, N. Y. Fauna, Fishes, 31, pl. 51, fig. 166, 1842; Holbrook, Ichth. S. C. 6, pl. 1, fig. 2, 1856.

Pomotis auritus Günther, Cat. Fish. Brit. Mus. I, 261, 1859.

Lepomis gibbosus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 482, 1883; Meek, Ann. N. Y. Ac. Sci. IV, 313, 1888; Bean, Fishes, Penna. 115, pl. 32, fig. 65, 1893.

Eupomotis aureus Mather, App. 12th Rept. Adirondack Surv. N. Y. 7, 1886.

Eupomotis gibbosus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1009, 1896, pl. CLXI, fig. 429, 1900; Bean, Bull. Am. Mus. Nat. Hist. IX, 364, 1897; Mearns, Bull. Am. Mus. Nat. Hist. X, 320, 1898; Eugene Smith, Proc. Linn. Soc. N. Y. 1897, 35, 1898; Bean, 52d Ann. Rept. N. Y. State Mus. 104, 1900.

The body of the common sunfish is nearly ovate, its depth one half the total length without caudal; its thickness one third of the depth. The caudal peduncle is short and compressed, its least depth less than the thickness of the body. The head is moderately large, one third of the total length without caudal, its width one half its length. The snout is short and depressed, its length four fifths of the diameter of the eye, which is one fourth as long as the head. The interorbital space is nearly flat, its width one and one half times the diameter of the eye. The mouth is small and oblique; the maxilla not much expanded behind and reaching to below the front of the eye. Scales on the cheeks in four rows. The opercular spot is short, less than two thirds the diameter of the eye, and has a whitish margin behind. The gill rakers are very short, moderately stout, 10 or 11 developed on the first arch, the longest less than

one fourth the diameter of the eye. The spinous dorsal begins over the third scale of the lateral line; its base is as long as the head without the opercular flap; the first spine is two thirds as long as the eye; the spines increase in size, the fourth, fifth and sixth being nearly equal in length and about as long as the eye and snout combined; the sixth and longest soft ray is as long as the postorbital part of the head, while the last ray is less than one third as long as the head. The base of the soft dorsal is as long as that of the spinous dorsal. The anal origin is under the 23d scale of the lateral line. The anal base is two thirds as long as the head; the first spine is about one half as long as the third (longest), which is two fifths as long as the head. The first and second rays are the longest, nearly as long as the base of the fin. The last ray is two thirds as long as the first. The ventral reaches beyond the vent; its spine is one half as long as the head without the snout. The pectoral reaches to above the anal origin. The caudal is emarginate, its middle rays four fifths as long as the outer. The lateral line follows the curve of the back. D. X, 12; A. III, 10; V. I, 5; P. 13. Scales 6–42–13.

In spirits the color is pale brownish, the opercular flap black with a narrow whitish margin behind and beneath, and the dorsal fin with faint dusky blotches. In life this is one of the most brilliant of sunfishes, the upper parts being greenish olive with a bluish tinge, the sides profusely spotted with orange, the belly and lower fins orange and the dorsal and caudal fins bluish with orange spots. The cheeks are orange with undulating blue stripes; the opercular flap is black, emarginated behind and underneath with bright scarlet.

The specimen described, no. 20304, U. S. National Museum, from the Susquehanna at Havre de Grace, is nearly 6 inches long.

The common sunfish, or sunny, pumpkin seed, bream, tobacco box, and pondfish is one of the best known fishes of the United States.

It is found from Maine westward through the Great lakes region to Minnesota and in the eastern states south to South

Carolina. In western rivers, however, it is seldom found south of the latitude of Chicago. In New York the sunfish abounds almost everywhere, in the lowlands as well as the highlands and in brackish as well as fresh waters; it has even been taken occasionally in salt water on Long Island. Large individuals have been received from Canandaigua lake and from lakes in the Adirondacks. Dr Meek found it very common throughout the Cayuga lake basin. The collectors of the U. S. Fish Commission obtained it in almost all the waters visited by them (21 localities) in the Lake Ontario region. Eugene Smith reports it from most of the moraine ponds of Long Island and Staten Island, and in quarry ponds of the Palisades, wherein it is frequently placed by boys. Ponds and lakes in the parks of New York city are well stocked with this species. Mearns reported it as abundant in the Hudson and in all the ponds and slow streams of the Hudson Highlands. Mather recorded it as a common fish in most of the Adirondack waters, the exceptions being Piseco lake, G lake, Coald lake, Sents' lake, T lake, Willis pond, Murphy, Warner and Bug lakes.

The common sunfish grows to a length of 8 inches and a weight of about $\frac{1}{2}$ pound. Its food is similar to that of the long-eared sunfish; and it is one of the readiest biters known to the angler. The habits of this fish have been described by Dr Theodore Gill and W. P. Seal. The latter states that the male in the breeding season is readily identified by his brighter coloration, conspicuous ear flaps and a luminous border around the fins while in the water. The nest is a depression in the mud, sand or gravel, hollowed out by means of the fins. In the Potomac he found a number of nests which were located from a few inches to several feet apart. The male watches the nest and drives away all intruders. The eggs are only about $\frac{1}{32}$ of an inch in diameter and not very numerous. They are attached to stones and aquatic plants. Mr Seal has reason to believe that the male alone is concerned in building the nest and in the care of the eggs and young.

The species is usually hardy in captivity, but is subject to fungus attacks which yield readily to treatment with brackish

water. In the aquarium, according to Eugene Smith, the common sunfish by incessant attacks often kills associates of many kinds. It is a very gamy fish, common everywhere and is usually found in the company of shiners, minnows and killies. In quarry ponds, of the Palisades, says the same author, the fish will thrive and multiply as freely as the goldfish, provided there is water enough throughout the year.

Genus MICROPTERUS Lacépède

Body oblong, compressed, the back not much elevated; head oblong, conical; mouth very large, oblique, the broad maxillary reaching nearly to or beyond the posterior margin of the eye, its supplemental bone well developed; lower jaw prominent; teeth on jaws, vomer and palatines in broad villiform bands, the inner depressible, usually no teeth on the tongue; preopercle entire; operculum ending in two flat points without cartilaginous flap; branchiostegals normally six; gill rakers long and slender; scales rather small, weakly ctenoid; lateral line complete, the tubes straight, occupying the anterior half of each scale; dorsal fin divided by a deep notch, the spines low and rather feeble, 10 in number; anal spines three, the anal fin much smaller than the dorsal; pectorals obtusely pointed, the upper rays longest; ventrals close together below the pectorals; caudal fin emarginate; posterior processes of the premaxillaries not extending to the frontals; frontals posteriorly with a transverse ridge connecting the parietal and supraoccipital crests, which are very strong; vertebrae 16+16 or 17+32 or 33. Size large. Two species, among the most important of American "game" fishes.

241 Micropterus dolomieu Lacépède

Small Mouthed Black Bass

Micropterus dolomieu LACEPEDE, Hist. Nat. Poiss. IV, 325, 1802; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 485, 1883; MATHER, App. 12th Rept. Adirondack Surv. N. Y. 5, 1886; MEEK, Ann. N. Y. Ac. Sci. IV, 313, 1888; BEAN, Fishes Penna. 116, color pl. 11, 1893; EVERMANN & KENDALL, Rept. U. S. F. C. for 1894, 600, 1896; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1011, 1896, pl. CLXII, figs. 430, 430*a*, 1900; BEAN, Bull. Am. Mus. Nat. Hist. IX, 364, 1897; MEARNS, id. X, 320, 1898; EUGENE SMITH, Proc. Linn. Soc. N. Y. 1897, 35, 1898.

Centrarchus obscurus De Kay, N. Y. Fauna, Fishes, 30, pl. 17, fig. 48, 1842, Onondaga Creek, N. Y.; Günther, Cat. Fish. Brit. Mus. I, 258, 1859.

The small mouthed bass differs most markedly from the large mouthed in the size of its jaws, the shallower notch in the dorsal fin and the smaller scales. There are about 11 rows of scales above the lateral line and seven below it; 72–74 scales in the lateral line. The ninth spine of the dorsal is longer than the eye and fully two thirds as long as the fifth and longest spine. The upper jaw extends backward to below the hind margin of the eye. The body is ovate oblong in shape, its greatest depth about equal to length of the head and one third of the total without caudal, becoming deeper with age. The eye is less than two thirds as long as the snout and about one sixth the length of head. The pectoral is not much longer than the ventral and slightly more than one half the length of head. The soft dorsal and anal are more scaly at the base than in the large-mouthed species. The scales on the cheeks and breast are very much smaller than those on the middle of the sides. D. X, 13–15; A. III, 10.

The young are dull yellowish green, the sides mottled with darker spots, which sometimes form short vertical bars. Three dark stripes on the head; caudal yellowish at the base; a broad black band near middle of tail and a broad whitish margin behind. The dark lateral band characteristic of the large mouthed species is not found in the small-mouth. In the adult the prevailing color is olive green, the stripes on the head remaining more or less distinct.

One of the early names for the small mouthed black bass is that of growler, which appears in the writings of Cuvier, who was under the impression that the name was applied because of a noise sometimes produced by this bass. At the time of his writing the name growler was pretty generally identified with the black bass. Among the names applied to this fish by Rafinesque are lake bass, big bass, spotted bass, and achigan. He also mentions it under the names painted tail, bridge perch, yellow bass, gold bass, brown bass, dark bass, minny bass, little

bass, hog bass, yellow perch, black perch, trout perch, streaked head, white trout and brown trout. In the southern states the small-mouth is known as the trout, perch and jumper. In Alabama it is called mountain trout. Some persons style it the bronze backer. The most appropriate name and the one by which it is best known is that of black bass or small mouthed black bass.

This species is indigenous to the upper parts of the St Lawrence basin, the Great lakes region and the basin of the Mississippi. East of the Alleghanies it is native to the headwaters of the Ocmulgee and Chattahoochee rivers, but north of these streams, though not originally an inhabitant of the waters, it has been widely distributed by artificial introduction.

In the St Lawrence river Evermann and Bean obtained the fish 3 miles below Ogdensburg N. Y. July 17, 1894, evidently the young of the year, as the specimen is $1\frac{3}{4}$ inches long. In Scioto creek at Coopersville N. Y. they secured an example $1\frac{5}{8}$ inches long July 19, 1894. Field assistants of the U. S. Fish Commission, collecting in the Lake Ontario region of New York in 1894 and preceding years, took specimens in the following localities.

Big Stony creek, Henderson Harbor
Mouth Salmon river, Selkirk
Marsh creek, Point Breeze
Four mile creek, Nine Mile point, Webster.
Wart creek
Black river, Huntingtonville
Cape Vincent
Mouth Little Salmon creek
Great Sodus bay
Sandy creek, North Hamlin
Long pond, Charlotte

Meek did not find this species in the vicinity of Ithaca. Near Cayuga and Montezuma it is less common than the large-mouthed black bass. Mather reported the species in Racquette, Forked, White, Fourth, Bisby and Sucker lakes, Black and Moose rivers, and in Partlo pond, St Lawrence county, in all of

which it has been introduced. The fish is not uncommon in Lake Champlain; it is abundant in the vicinity of Caledonia N. Y. Eugene Smith records it from the Passaic river. The writer has found it abundant in the Bronx. Mearns mentions it from Long pond, in the Hudson Highlands, where it reaches the weight of 5 or 6 pounds.

This bass does not grow so large as the large mouthed, seldom exceeding 8 pounds in weight and averaging but $2\frac{1}{2}$ pounds. A fish of the latter weight will measure 15 inches in length, while one of 8 pounds will measure 2 feet.

The food of the black bass consists of crawfish, frogs, insects and their larvae, minnows and other aquatic animals of suitable size. The young can be fed on small fresh-water crustaceans, such as Daphnia and Cyclops. Among the successful baits for this species are stone catfish, hellgramites and crickets.

The black bass prefers rapid water, is extremely active, and frequents clear, pure, swiftly flowing streams, and thrives at greater elevations than those preferred by the large mouthed species. It hibernates in the winter and spawns in the shallows on gravelly bottoms in spring. It follows its prey into shallow water and frequently leaps far out of the water in its efforts to escape from the hook or when frightened by the sudden approach of an enemy. It swims in schools and is often found in the shelter of sunken logs and in the vicinity of large rocks.

The spawning season begins in March and ends in July. The period of incubation lasts from seven to 14 days. The eggs are bound together in bands or ribbons by an adhesive substance. They adhere to stones on which they are deposited. The parent fish build nests and protect the eggs and young. In the Delaware the current is more rapid and the temperature lower than in the Susquehanna; hence the bass spawn earlier in the latter than in the former. The spawning fish have nearly all left their spawning beds in the Susquehanna early in July, but at this time most of the nests in the Delaware are still full of eggs. By some writers it is believed that the female prepares the nest before the male joins her. The males fight for the

possession of the female and are said to help the process of ejecting the eggs by biting or pressing the belly of the female. After the eggs are deposited, the female guards the nest from the attacks of the crawfish and other fishes. The young are consumed by many birds and by frogs and snakes. Yet, notwithstanding the numerous enemies of the black bass, its multiplication has been rapid and enormous.

The small mouthed black bass ceases to take food on the approach of cold weather and remains nearly dormant through the winter, except in artificially heated water. A number of the young of the year, received from James Annin jr of Caledonia N. Y. Oct. 6, 1896, scarcely fed at all in the following winter, but when the spring was advanced they fed eagerly and grew rapidly.

242 Micropterus salmoides Lacépède

Large mouthed Black Bass

Labrus salmoides Lacépède, Hist. Nat. Poiss. IV, 716, 1802, South Carolina.
Huro nigricans Cuvier & Valenciennes, Hist. Nat. Poiss. II, 124, pl. 17, 1828, Lake Huron; De Kay, N. Y. Fauna, Fishes, 15, pl. 69, fig. 224, 1842; Günther, Cat. Fish. Brit. Mus. I. 255, 1859.
Micropterus pallidus Goode & Bean, Bull. Essex Inst. XI, 19, 1879.
Micropterus salmoides Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 484, 1883; Meek, Ann. N. Y. Ac. Sci. IV, 313, 1888; Bean, Fishes Penna. 118, pl. 32, fig. 66, 1893; Bull. Am. Mus. Nat. Hist. IX, 364, 1897; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1012, 1896, pl. CLXIII, fig. 431, 1900; Mearns, Bull. Am. Mus. Nat. Hist. X. 320, 1898; Eugene Smith, Proc. Linn. Soc. N. Y. 1897, 36, 1898; Bean, 52d Ann. Rept. N. Y. State Mus. 105, 1900.

The large mouthed black bass takes its common name from the size of its jaws; the lower jaw projects very strongly, and the maxilla in the adult extends beyond the hind margin of the eye. The depth of the body is about one third of the total without caudal, and does not equal the length of the head. The eye is shorter than the snout, about one sixth of the length of the head. The pectoral is half as long as the head, much longer than the ventral. The spinous dorsal is very low, its ninth and 10th spines not so long as the eye, its fourth spine longest, about one fourth the length of head. Seven to eight scales above the lateral line, below 16 and in the lateral line about

68. The color is greenish, silvery below. The young have a broad dark lateral band. D. X, 13; A. III, 10–11.

This species may best be distinguished from the small mouthed black bass by the size of its mouth and the number of rows of scales above the lateral line. The young of the small mouthed species, also, never have a dark lateral band.

Common names for this species are, Oswego bass, river bass, green bass, moss bass, bayou bass, trout, jumper, chub and Welshman. Throughout the north it is generally known as bass, in Virginia and North Carolina as chub and in Florida and west to Texas as trout.

The large mouthed bass has a wide distribution, being indigenous to the eastern United States, from Manitoba to Florida and Texas, except New England and the Middle Atlantic states east of the Alleghanies, where it has been extensively introduced. It inhabits the fresh-water ponds, lakes and sluggish streams. It is found also at the mouths of rivers emptying into the Gulf of Mexico, where the water is brackish.

Dr Meek found the large mouthed species scarce near Ithaca and more common near Montezuma and Cayuga. James Annin jr collected the young at Caledonia. The U. S. Fish Commission had it from the following places in the Lake Ontario region:

Lakeview hotel, 7 m. n. e. of Oswego
Marsh creek, Point Breeze
Mouth Salmon river, Selkirk
Mouth Little Salmon creek
Stony Island
Four Mile creek, Nine Mile point, near Webster
Creek at Pultneyville
Chaumont river
Great Sodus bay
Three Mile creek, Oswego
Long pond, Charlotte

Dr Mearns first observed the species in the Hudson in the autumn of 1882, where the fish were caught in fyke nets during October and November. Eugene Smith records it from all lakes and rivers adjacent to New York city.

Young individuals, from 1½ to 2 inches long, were seined in Bronx river in August 1897.

The average weight of the large mouthed bass in southern waters is less than 5 pounds, and still less in northern waters. In Florida it attains a large size, as much as 3 feet in length, and a weight of 25 pounds. Its growth and size depend on the waters where it is found, and the natural food supply of small fish, crawfish and frogs.

It is a very active fish; its movements are affected by seasonal changes and the search for food and places for spawning. In polluted streams the bass are often compelled by the impurities to seek new haunts in pure water. The young bass feed on animal food at an early age. The large mouthed bass is said to be more cannibalistic than the small mouthed. Small fishes (minnows) of all kinds, crawfish, frogs, insects and their larvae, and aquatic animals of all kinds, suitable in size, make up the diet of this fish. It feeds both at the surface and on the bottom, pursuing its prey with great activity. When surrounded by seines or caught on hooks this species will often leap 5 or 6 feet out of the water, and its habit of jumping over the cork lines of seines has given it the name of "jumper."

In cold weather the bass seeks deep places, often hibernating under rocks, sunken logs and in the mud. Favorite localities are under overhanging and brush-covered banks, in the summer, and among aquatic plants, where the fish lies in wait for its prey.

The spawning season of the large mouthed bass is about the same as that of the small mouthed species, beginning in April and lasting till July. Its eggs are adhesive, sticking to stones during the incubation period, which lasts from one to two weeks according to the temperature of the water. The young bass remain in the nest a week or 10 days, and at the age of two weeks will measure about ¾ of an inch in length. In suitable waters it is estimated that the large mouthed bass will weigh at the age of three years from 2 pounds to 4 pounds.

The Oswego bass is even more destructive to fish than M. dolomieu. It will eat any fish which it can manage to get

into its mouth and will lie on the bottom for days so gorged that it can not stir. In voracity it is only equaled, but hardly excelled by the pike. This bass bears captivity well. (After Eugene Smith[1])

The young above referred to as coming from Caledonia N. Y. hibernated and took scarcely any food during the winter, but fed ravenously in spring, summer, and fall. They proved very hardy in captivity.

Family PERCIDAE

Perches

Genus STIZOSTEDION Rafinesque

Body elongate, fusiform, the back broad; head subconical, long; cheeks, opercles, and top of head more or less scaly; mouth large, the jaws about equal; premaxillaries protractile, little movable; teeth in villiform bands, the jaws and palatines with long, sharp canines; gill rakers slender, strong; gill membranes separate; preopercle serrated, the serrae below turned forward; opercle with one or more spines, terminations of radiating striae; dorsal fins well separated, the first with 12 to 15 spines, the second with 17 to 21 soft rays, last dorsal spine not erectile, bound down by membranes; anal spines two, slender, closely appressed to the soft rays, which are rather long, 11 to 14 in number; ventral fins well separated, the space between them equal to their base, ventral spine slender, closely appressed to the soft rays; scales small, strongly ctenoid; lateral line continuous; branchiostegals seven; pseudobranchiae well developed; pyloric caeca three to seven. Two species, differing considerably from each other. Large carnivorous fishes of the fresh waters of North America.

Subgenus STIZOSTEDION

243 Stizostedion vitreum (Mitchill)

Pike Perch; Pike; Wall-eyed Pike

Perca vitrea MITCHILL, Am. Month. Mag. II, 247, Feb. 1818, Cayuga Lake, N. Y.

Lucioperca americana CUVIER & VALENCIENNES, Hist. Nat. Poiss. II, 122, 1828, New York; DE KAY, N. Y. Fauna, Fishes, 17, pl. 50, fig. 163, 1842; GÜNTHER, Cat. Fish. Brit. Mus. I, 74, 1859.

[1]Linn. Soc. N. Y. Proc. 1897, no. 9, p. 36.

Stizostedium vitreum JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 525, 1883.
Lucioperca vitrea EUGENE SMITH, Proc. Linn. Soc. N. Y. 1897, 38, 1898.
Stizostedion vitreum MEEK, Ann. N. Y. Ac. Sci. IV, 314, 1888; BEAN, Fishes Penna. 127, color pl. 13, 1893; EVERMANN and KENDALL, Rept. U.S.F.C. for 1894, 601, 1896; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1021, 1896, pl. CLXIV, fig. 333, 1900; BEAN, Bull. Am. Mus. Nat. Hist. IX, 364, 1897.

The pike perch belongs to the genus Stizostedion, which has been distinguished from the saugers by the structure of its pyloric caeca, which are three in number, nearly equal in size, and about as long as the stomach, and also by the presence of 21 soft rays in the second dorsal, while the saugers have 18. It may be remarked that all of these characters are more or less variable. The S. vitreum has the body long and moderately deep, its depth varying with age and equaling from one sixth to one fourth of the total length without caudal; the length of the head is contained in the same standard four and two thirds times; the eye is moderate, about two thirds as long as the snout and a little more than one sixth of the length of the head; the lower jaw projects slightly; the maxilla reaches to beyond the pupil; the cheeks and opercles are more scaly than in the saugers; the soft dorsal is nearly as long as the spinous; length of longest dorsal spine about half the length of head. D. XIII, I, 21; A. II, 12 to 13. About 90 scales in lateral line, 10 above and 19 below. The pectoral reaches to below the 10th spine of the dorsal; it is as long as the ventral and one half the length of head; the vent is under the fifth ray of the second dorsal.

Color olivaceous, mingled with brassy; sides of the head vermiculated; the dorsals, caudal and pectoral with bands; those of the dorsals and caudal not continuous; sides with about seven oblique dark bands, differing in direction; a jet black blotch on the membrane behind the last spine of the dorsal.

The pike perch has received a great many common names. One of the most unsuitable is "Susquehanna salmon," which is used in Pennsylvania. In the eastern states the species is styled the perch pike or the pike perch, glasseye and wall-eyed pike. In the Great lakes region it is known as blue pike, yellow pike, green pike and grass pike. In the Ohio valley and western North Caro-

lina it is the jack; in Lake Erie and Canada, the pickerel; in some parts of the Ohio valley, the white salmon or jack salmon. The Cree Indians call it the *okow* and the French Canadians *doré* or *picarel*. Among the fur traders of British America it is called the hornfish.

The pike perch or wall-eyed pike inhabits the Great lakes region and extends northward into British America, where it has been recorded as far as 58° north by Dr Richardson. It ranges south in the Mississippi valley to Arkansas, and in Atlantic streams to Georgia. According to Dr Meek the species is found in Cayuga lake, but is not common. In Lake Champlain it is one of the principal game fishes. James Annin jr of Caledonia obtained specimens in the Canandaigua lake region. It has been introduced into numerous lakes by the Fisheries, Game and Forest Commission of New York. The U. S. Fish Commission secured examples in the Oswego river at Oswego and at Point Breeze in August 1894.

This species is said to reach a weight of 50 pounds, but the average weight of the market specimens is less than 5 pounds. In the Susquehanna it occasionally reaches 10 pounds or upward in weight. The pike perch feeds on the bottom on other fishes, and has been charged even with destroying its own young. It prefers clear and rapid waters, and lurks under submerged logs and rocks, from which it can readily dart on its prey. Spawning takes place in April and May, and in Pennsylvania continues till June. Favorite spawning localities are on sandy bars in shallow water. The period of hatching varies from about 14 to 30 days, depending on the temperature of the water. The eggs vary from about 17 to 25 to the inch, and a single female has been estimated to contain from 200,000 to 300,000. In a state of nature only a small percentage of the eggs are hatched out; the greater proportion are driven on the lake shores by storms or devoured by fishes on the spawning beds. The number of pike perch annually hatched by artificial methods is enormous. This advance is due to improvements in the treatment of adhesive eggs. Formerly these were hatched by placing them on glass plates, to

which they readily adhere. Recently it has been found that the sticky substance can be washed off the eggs, after which they are placed in jars and hatched like eggs of the shad and whitefish.

"Dexter," in *Forest and Stream*, Aug. 14, 1890, makes the following statement about the habits of this species in the lakes.

> These fish run up the rivers before or as soon as the ice is out, and after spawning lie off the river's mouth feeding on and off the sand flats, as the spring rains bring down plenty of worms, and probably other matter which they feed on. As soon as the water gets warm, they sag off and work along the shores in 10 to 30 feet of water, preferring cobbly bottom; from here they go into very deep water, coming on the reefs to feed, and when the wind blows very hard, or for a day or so after a big blow, you will find them right on top of a reef. I think the wind changes the water over the reefs, making a new current and cooler water, so they come up to feed. They are a bottom fish, and to fish for them successfully one must go to the bottom for them. They are nearly as particular as salmon trout about the water they inhabit and consequently rank very high as a food fish, being white, solid and extremely free from bones.

The colors of the pike perch change remarkably with age. The young have oblique dark bands much like those of the kingfish of our east coast, and bear little resemblance in the pattern of coloration to the parent. The eye of the living fish is like a glowing emerald. The rate of growth must be rapid. In July 1888 we took examples from 4 to 6 inches long, some of which seemed to be the young of the year.

This is one of the finest food and game fishes of the United States. Its flesh is firm and white, flaky and well flavored. Commercially the species ranks high in the Great lakes region, being next in importance to the whitefish. In angling for the pike perch live minnows are used in preference to all other baits, particularly such as are more or less transparent and with silvery sides, as the fallfish or dace, the corporal roach, the redfin and the gudgeon. On some parts of the Susquehanna, between Columbia and Harrisburg, the favorite mode of capture is by trolling with the spoon with the same kind of tackle as is used for the black bass.

James Annin jr of Caledonia sent two individuals Ap. 23, 1896, for identification. They furnished the following notes and measurements in inches.

	♀	♂
Length, including caudal	18¾	18
Length to end of middle caudal rays	18	17⅞
Depth of body	3½	3½
Least depth of caudal peduncle	1⅛	1¼
Length of head	4¾	4⅜
Length of snout	1¼	1⅛
Diameter of eye	⅛	⅛
Length of maxilla	2	1⅞
Length of mandible	2¾	2½
Dorsal	XIV, I, 21	XIV, I, 20
Anal	III, 11	III, 11
Scales	92	93

The pyloric caeca are long and loaded with fat. The male is brassy; the female gray and whitish.

In November of 1896 and 1897 Mr Annin shipped adult individuals from Canandaigua lake by express without an attendant, and there was scarcely any loss of fish in transportation, though the journey lasts 12 hours.

The blue pike of Lake Erie, or white salmon of the Ohio river, was formerly distinguished by name from the common pike perch, but is now considered unworthy of a separate name. This is a very small variety seldom exceeding 15 inches in length and a weight of 2 pounds. The dorsal has 14 spines and 20 rays. The spines are rather lower than in the pike perch, the coloration similar, but the adult is bluish or greenish and has no brassy mottling. The fins are darker, and there is a trace of a band along the dorsal, besides the black blotch on the hind portion.

Jordan & Evermann say of this variety: "The name s a l m o n e u m has been applied to the so called 'blue pike' originally described from the Ohio river, but more common in the Great lakes, particularly Ontario and Erie. It is smaller and deeper in body than the ordinary v i t r e u m and different in color, but it is not likely that any permanent distinctions exist, this species, as usual among fresh-water fishes, varying largely with the environment and with age."

Subgenus CYNOPERCA Gill & Jordan

244 Stizostedion canadense (Smith)

Sauger; Sand Pike

Lucioperca canadensis C. H. SMITH, in Griffith's Cuv. Règne Anim. X, 275, pl. 7, 1834; DE KAY, N. Y. Fauna, Fishes, 19, pl. 68, fig. 221, 1842 (extralimital); GÜNTHER, Cat. Fish. Brit. Mus. I, 75, 1859.

Stizostedium canadense JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 526, 1883.

Stizostedion canadense MEEK, Ann. N. Y. Ac. Sci. IV, 314, 1888; BEAN, Fishes Penna. 130, pl. 34, fig. 70, 1893; EVERMANN & KENDALL, Rept. U. S. F. C. for 1894, 601, 1896; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1022, 1896, pl. CLXIV, fig. 434, 1900.

Body slender, not much compressed, roundish; its depth contained four and one half to five times in the total without caudal. The head is pointed, about two sevenths of standard length and contains the eye five to five and one half times. The mouth is smaller than in the pike perch; the maxilla reaches to the hind margin of the eye. D. XII to XIII, I, 17 to 18; A. II, 12. Scales 92 to 98; 4 to 7 pyloric caeca, unequal in size and all of them shorter than the stomach.

Color olivaceous above; sides brassy or pale orange, mottled with black in the form of irregular dark blotches, which are best defined under the soft dorsal. The spinous dorsal has several rows of round black spots on the membrane between the spines; no black blotch on the hind part of the spinous dorsal. Pectorals with a large dark blotch at base; soft dorsal with several rows of dark spots irregularly placed; caudal yellowish with dark spots forming interrupted bars.

The sauger is known also as sand pike, gray pike and green pike, pickering, pickerel and horsefish. It is found in the St Lawrence river and Great lakes region, the upper Mississippi and Missouri rivers and in the Ohio, where it is said to have been introduced from the lakes through canals. This is a small fish, seldom exceeding 18 inches in length, and embraces several varieties. It is very common in the Great lakes and is abundant in the Ohio river. It is doubtful whether it is native to Ohio or introduced. It is also found rarely in Cayuga lake. Rev. Zadock Thompson, in his *History of Vermont*, says it is much

less common in Lake Champlain than the pike perch, but is frequently taken in company with it. It usually swims very near the bottom of the water, and hence it has received the name of ground pike (pike perch). As an article of food this species is locally held in the same high esteem as the common pike perch.

John W. Titcomb of St Johnsbury Vt. informed Evermann and Kendall that the sauger, or rock pike, as it is locally called, is caught in seines while fishing for the pike perch. It does not grow as large as the latter, and is not much valued as a food fish. The authors mentioned received two examples of the fish from A. L. Collins of Swanton Vt., one of them a nearly ripe female 14½ inches long, weighing three fourths of a pound, the other an unripe male 15 inches long, weighing three fourths of a pound. These specimens were believed to indicate that the sauger spawns earlier than the pike perch. The stomach of the male contained a three inch minnow, too badly digested for identification, and a number of small insects.

It is very extensively used for food, but is not generally considered equal to the pike perch.

245 Stizostedion canadense griseum (DeKay)

Gray Pike; Sauger; Sand Pike

Lucioperca grisea De Kay, N. Y. Fauna, Fishes, 19, 1842, Great Lakes; streams and inland lakes of western New York; Günther, Cat. Fish. Brit. Mus. I, 76, 1859.

Lucioperca pepinus Estes, in Hallock's Sportman's Gazetteer, 322, 1877, Lake Pepin.

Stizostedium canadense var. *griseum* Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 526, 1883.

Stizostedion canadense griseum Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1022, 1896.

This is the common sand pike or sauger of the Great lakes region and southwestward. It differs from the typical canadense chiefly in the smoother opercles and head bones, the fewer opercular spines, and the less complete scaling of the head. The two need fuller comparison and may prove to be distinct species, but this is unlikely. Length 10 to 18 inches.

Genus PERCA (Artedi) Linnaeus

Body oblong, somewhat compressed, the back elevated; cheeks scaly; opercles mostly naked; the operculum armed with a single spine; preopercle and shoulder girdle serrated; preopercle with retrorse, hooked serrations below; mouth moderate, terminal; premaxillaries protractile; teeth in villiform bands on jaws, vomer, and palatines, no canine teeth; branchiostegals seven; gill membranes separate; pseudobranchiae small, but perfect; no anal papilla; scales rather small, strongly ctenoid, lateral line complete, the tubes straight and not extending to the extremity of the scale; dorsal fins entirely separate, the first of 12 to 16 spines; anal fin with two slender spines, well separated from the soft rays; ventral spines well developed, the ventral fins near together; caudal emarginate; air bladder present; pyloric caeca three; vertebrae very numerous, 21+20 or 21=41 or 42. Fresh waters of northern regions; three closely related species now known, P e r c a f l u v i a t i l i s in Europe, P. s c h r e n c k i i in Asia, and P. f l a v e s c e n s in North America.

246 Perca flavescens (Mitchill)

Yellow Perch; Ring Perch

Morone flavescens MITCHILL, Report in Part, 18, 1814.

Bodianus flavescens MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 421, 1815.

Perca serrato-granulata CUVIER & VALENCIENNES, Hist. Nat. Poiss. II, 47, 1828, New York; DE KAY, N. Y. Fauna, Fishes, 5, pl. 22, fig. 64, 1842.

Perca granulata CUVIER & VALENCIENNES, op. cit. II, 48, pl. IX, 1828, New York; DE KAY, op. cit. 5, pl. 68, fig. 220, 1842.

Perca acuta CUVIER & VALENCIENNES, op. cit. II, 49, pl. X, 1828; DE KAY, op. cit. 6, pl. 68, fig. 222, 1842.

Perca gracilis CUVIER & VALENCIENNES, op. cit. II, 50, 1828, Skaneateles Lake, N. Y.; DE KAY, op. cit. 6, 1842; GÜNTHER, Cat. Fish. Brit. Mus. I, 60, 1859.

Perca americana JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 524, 1883.

Perca flavescens CUVIER & VALENCIENNES, op. cit. II, 46, 1828; DE KAY, op. cit. 3, pl. 1, fig. 1, 1842; GÜNTHER, op. cit. 1, 59, 1859; STORER, Hist. Fish. Mass. 4, pl. II, fig. 1, 1867; MEEK, Ann. N. Y. Ac. Sci. IV, 314, 1888; BEAN, Fishes Penna. 126, color pl. 12, 1893; EVERMANN & KENDALL, Rept. U. S. F. C. for 1894, 602, 1896; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1023, 1896, pl. CLXV, fig. 435, 1900; BEAN, Bull. Am. Mus. Nat. Hist. IX, 365, 1897; MEARNS, Bull. Am. Mus. Nat. Hist. X, 320, 1898; EUGENE SMITH, Proc. Linn. Soc. N. Y. 1897, 37, 1898.

The yellow perch has a fusiform and moderately elongate body, its greatest hight at the ventral origin two sevenths of the total length without the caudal and nearly equal to the length of the head. The least depth of the caudal peduncle equals one third of length of head. The greatest width of the body equals one half its greatest hight. The head is moderately long, its length contained three and one fourth times in the standard, with pointed snout, one and one third times as long as the eye. The interorbital region is flat, its width one and one half times the diameter of the eye. The mouth is rather large, the jaws equal, and the maxilla reaching to below middle of pupil. The preopercle is coarsely dentate on its hind margin, the teeth on the superior border directed partly upward and partly backward, those on the lower limb pointing downward and some of them forward. The scapula and humerus are finely serrate. Scales on the cheeks in about 13 rows from before backward; a single row or two imperfect rows of scales on the subopercle; four short rows of scales on the upper anterior part of the opercle. Gill rakers 6–14, the longest one half as long as the eye. The spinous dorsal begins over the base of the pectoral; the first spine is one third as long as the head to the end of the opercular spine; the fourth and longest spine is as long as the eye and snout combined; the last spine is minute and concealed in the dorsal furrow. The soft dorsal in the specimen described is preceded by two spines, the first two thirds as long as the eye and one half as long as the second; the longest ray is as long as the longest spine, and twice as long as the last ray. The ventral origin is under the fourth spine of the dorsal; the fin equals one fifth of the total length without the caudal. The anal origin is under the fourth or fifth soft dorsal ray; the first anal spine one third as long as the head and nearly as long as the second; the last anal ray less than one half as long as the longest, which is one half as long as the head. The caudal is notched, the middle rays contained one and one third times in the length of the outer rays. The pectoral is as long as the ventral. D. XV, II, 13; A. II, 8;

V. I, 5; P. 15. Scales 7-57-13. The lateral line curves upward in a long curve following the dorsal outline till below the end of the soft dorsal, where it becomes straight and median. Color olivaceous varying into greenish or bluish, the sides yellow, with about six to eight dark bands, the widest wider than the eye is long. The upper fins are olivaceous, the lower orange and rosy. The specimen described, no. 22862, U. S. National Museum, Washington D. C., is 9 inches long.

The yellow perch, ringed perch or striped perch is found throughout the Great lakes region, rivers and ponds of New England and northwestward, and in streams east of the Alleghanies south to Georgia. It does not occur in the Ohio valley or southwest, though, after the construction of the Ohio canal, Kirtland recorded it from the Ohio river. In 1790 Dr Mitchill transferred some of them from Ronkonkoma to Success pond, a distance of 40 miles, where they soon multiplied. In 1825 yellow perch were transported from Skaneateles to Otisco lake and Onondaga lake; in the latter they increased remarkably. In Otsego lake DeKay caught some weighing nearly three pounds. Meek states that the species is common throughout the Cayuga lake basin. Evermann and Bean took it in the St Lawrence river, 3 miles below Ogdensburg; also in Scioto creek, Coopersville N. Y., July 19, 1894, young specimens $1\frac{1}{2}$ to $1\frac{3}{4}$ inches long. In the Lake Ontario region the U. S. Fish Commission collectors obtained it at the localities in this state here mentioned.

Mouth of Salmon river
Mouth of Little Salmon creek
Black creek, tributary of Oswego river, Scriba Corners
Sandy creek, Hamlin
Grenadier island
Stony island
Chaumont river
Outlet of Long pond, Charlotte
Little Stony brook, Henderson bay
Cape Vincent

Creek at Pultneyville
Great Sodus bay
Four Mile creek, 1 mile above mouth
Lakeview hotel, 7 m. n. e. of Oswego
Three Mile creek, near Oswego
Long pond, Charlotte
Salt brook, 1½ miles above Nine Mile point.

The yellow perch is one of the most abundant fishes of Lake Champlain and in the mouths of rivers falling into that lake.

The fish abounds in the parks of New York and Brooklyn. In the Hudson Highlands Dr Mearns reported it as abundant in the Hudson as well as in all of the larger mountain lakes and ponds. It habitually frequents Poplopen's creek from its source to its mouth. In the Hudson, he was informed, it is unusual to take specimens weighing more than 1 pound; but in Poplopen's pond he has taken a number that weighed about 2 pounds each. In the same pond Jerome Denna caught two which weighed 2½ to 3 pounds each; and a fisherman named Samuel Runnels assured Dr Mearns that he had taken a yellow perch there which weighed 4¼ pounds. The fish continue to feed in that region throughout the winter. Eugene Smith obtained the fish in Greenwood lake, Orange co., and in Hackensack streams, in Rockland county.

The species reaches a length of 1 foot and weight of two pounds. It is one of the best known of our food fishes and has excellent game qualities. Its flesh, however, is rather soft and coarse and is far inferior to that of the black bass and other members of the sunfish family. It is a voracious feeder, its food consisting of small fishes, crustaceans and other animal matter.

The yellow perch spawns early in the spring. The eggs are adhesive and inclosed in thin translucent strips of adhesive mucus. The spawning of this species was described by William P. Seal in *Forest and Stream* of Ap. 17, 1890. The spawning season extends from December to April. Mr Seal describes the egg mass as having the shape of a long tube, closed at the ends

and arranged in folds like the bellows of an accordion. When folded the mass was about 8 to 12 inches long, but was capable of being drawn out to a length of 3 or 4 feet. Spawning in the aquarium took place at night and was observed by William Maynard, who describes it as follows. "The female remained quiet in one spot on the bottom of one of the hatching aquaria tanks, one or more of the males hovering over and about her with pectoral fins vibrating with intense activity. The males would at times lie close alongside of her and at other times endeavor to force themselves under her with the evident intention of assisting in the extrusion of the eggs." Mr Seal remarks that "the roe when taken from the dead fish not yet ripe is in a single compact mass, covered by a thin membrane; but in spawning the mass separates, one side being spawned before the other." This was noticed in a specimen which had spawned one side and appeared to be unable to get rid of the other. It was stripped from her and artificially fertilized successfully. Mr Seal believes that the yellow perch spawns at the age of one year.

The yellow perch thrives moderately in captivity, though susceptible to attacks of fungus, which are easily overcome by the use of brackish water. Its food in captivity consists chiefly of chopped hard clams; sometimes live killifish are used.

Genus PERCINA Haldeman

Body elongate, slightly compressed, covered with small, ctenoid scales; lateral line continuous; ventral line with enlarged plates which fall off, leaving a naked strip; head depressed, rather pointed, the mouth being small and inferior, overlapped by a tapering, subtruncate, piglike snout; upper jaw not protractile, maxillary small, exposed; teeth on vomer and palatines, gill membranes scarcely connected; dorsal fins well separated, the first the larger, of 13 to 15 spines, the second dorsal rather longer than the anal, which has two spines, the first of which is usually the shorter; pectorals symmetric, rounded or bluntly pointed, their rays 14 or 15, their spines moderate; ventral fins well separated, the interspace about

equal to their base; air bladder and pseudobranchiae present, rudimentary; vertebrae (P. caprodes) 23+21=44. General pattern of coloration olivaceous, with dark vertical bands alternately long and short. Size largest of the darters, approaching that of Aspro, a genus to which it is more nearly related than the other darters are.

247 Percina caprodes (Rafinesque)

Log Perch; Hogmolly

Sciaena caprodes Rafinesque, Am. Month. Mag. 534, 1818, *fide* Jordan & Evermann.

Ethcostoma caprodes Rafinesque, Ichth. Ohien. 38, 1820; Storer, Syn. Fish. N. A. 18, 1846; Bean, Fishes Penna. 122, pl. 33, fig. 68, 1893.

Pileoma semifasciatum De Kay, N. Y. Fauna, Fishes, 16, pl. 50, fig. 162, 1842; Gunther, Cat. Fish. Brit. Mus. I, 76, 1859.

Percina caprodes Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 499, 1883; Evermann & Kendall, Rept. U. S. F. C. for 1894, 602, 1896; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1026, 1896, pl. CLXV, fig. 436, 436a, 1900.

Body long, moderately compressed; head long, with pointed snout; mouth small, the lower jaw not reaching near to tip of snout, and the maxilla not extending to the front of the eye. The head forms one fourth of the total length without the caudal, and the depth equals about one sixth. Scales on cheeks and gill covers, also on the space before the first dorsal; breast scaleless. A row of enlarged plates on the belly, which are sometimes deciduous. Fins moderately low and rather long. D. XV, 15; A. II, 9. Lateral line with 92 scales. Color greenish yellow; sides with about 15 dark cross bands, extending from back to belly; alternating with these above the lateral line are fainter bars. Fins barred. A black spot at the base of the caudal.

The log perch, hogfish, hogmolly, rockfish or crawl-a-bottom is found in the Great lakes region, Quebec and the eastern states south to Virginia, also in the Mississippi valley south to Alabama and Texas. De Kay obtained it at Westport on Lake Champlain, where it appeared to be very abundant, as well as in many streams in that vicinity. Its local name there he gives as little pickerel or pickerel, which it shared in common with

many other species. Evermann and Kendall had it from Rouse Point and Plattsburg, on the west shore of Lake Champlain.

This is the largest of the darters, reaching a length of 8 inches, and in many respects resembles the perches. It takes the hook very readily. The log perch is found in rapid streams with gravelly or rocky bottom and prefers clear waters.

248 **Percina caprodes zebra** (Agassiz)

Manitou Darter

Pileoma zebra Agassiz, Lake Superior, 308, pl. IV, fig. 4, 1850.
Percina manitou Jordan, Proc. Ac. Nat. Sci. Phila. 53, 1877.
Percina caprodes var. *manitou* Jordan and Gilbert, Bull. 16, U. S. Nat. Mus. 500, 1883.
Percina caprodes zebra Jordan and Evermann, Bull. 47, U. S. Nat. Mus. 1027, 1896.

Head four and one fourth; depth seven; nape always naked; lateral black bars short, shorter than in caprodes, not extending much above lateral line, these also more or less confluent, about 20 in number; a black caudal spot; dorsal and caudal mottled. D. XV–14; A. II, 10. Scales 90.

Lakes of northern Indiana, Michigan, Wisconsin and northward to Lake Superior; the common form in the Great lakes. The typical zebra is well distinguished from caprodes, but specimens variously intermediate have been obtained in Illinois by Dr Forbes, and in the Potomac by Dr Bean. (After Jordan and Evermann)

Evermann and Bean obtained the Manitou darter in the Racket river, at Norfolk N. Y. and in the St Lawrence 3 miles below Ogdensburg; also in Scioto creek, at Coopersville N. Y. Collectors for the U. S. Fish Commission secured specimens at the following places in 1893:

Nine Mile point, Lake Ontario	June 11
Grenadier island	June 27
Horse island, Sackett's Harbor	June 30
Mouth Salmon river, Selkirk	July 25
Mouth Little Salmon creek	July 25
Marsh creek, Point Breeze	Aug. 2

Genus HADROPTERUS Agassiz

Body rather elongate, compressed or not; mouth rather wide, terminal, the lower jaw included, the snout above not protruding beyond the premaxillaries, which are not protractile; teeth on vomer and usually on palatines also; gill membranes separate or more or less connected; scales small, ctenoid, covering the body; belly with a median series of more or less enlarged spinous plates or ctenoid scales, which in most species fall off at intervals, leaving a naked strip, in some species persistent and but slightly enlarged; sides of head scaly or not; lateral line complete or nearly so; fins large, the soft dorsal smaller than the spinous or the anal; anal spines two (one of them very rarely obsolete); dorsal spines 10 to 15; ventral fins more or less widely separated, specially in species with caducous plates. Vertebrae 39 to 44; H. aspro, 19+23=42; H. evides, 18+22=40; H. sciurus, 18+22=40; H. phoxocephalus, 19+20=39. Parietal region more or less depressed, not strongly convex in cross-section; supra-occipital crest usually present, but small. Pyloric caeca two to four. Coloration bright, often brilliant, sides usually with dark blotches.

Subgenus ALVORDIUS Girard

249 **Hadropterus aspro** (Cope & Jordan)

Black-sided Darter

Alvordius aspro Cope & Jordan, Proc. Ac. Nat. Sci. Phila. 51, 1877, substitute for *Etheostoma blennioides* of Kirtland and Agassiz; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 501, 1883.

Etheostoma aspro Bean, Fishes Penna. 123, 1893.

Hadropterus aspro Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1032, 1896, pl. CLXVI, fig. 438, 1900.

Body slender, fusiform, elongate, its greatest depth one sixth of length without caudal; least depth of caudal peduncle nearly one third of length of head; head rather long and pointed, one fourth of total length without caudal; the maxilla extends slightly past front of eye; the mandible is included; the eye large, equal to length of snout and to one fourth the length of head; gill membranes slightly connected; postorbital part of head a little longer than the remainder; the nape scaly or naked; cheeks

with very small scales, sometimes hardly visible; large scales on opercles; dorsal origin at a distance from eye equal to length of pectoral, base of spinous dorsal nearly equal to one third of total length without caudal, fourth to seventh spines longest, equal to snout and eye combined, last spine two thirds as long as the first and equal to snout; base of second dorsal one half as long as first, the longest ray twice as long as last ray and equal to postorbital part of head; the caudal peduncle rather long and slender, from end of second dorsal to end of scales being nearly equal to the head; caudal fin slightly emarginate, the middle rays three fourths as long as the external, and one third of length of head; the anal origin at a distance from tip of snout equaling twice the length of spinous dorsal base, the anal base equal to postorbital length of head, the two spines nearly equal, about one third as long as the head, the longest ray (fifth) equal to one half the length of spinous dorsal base; the ventral not far behind the base of the pectoral, its length about one half the distance from its origin to origin of anal; pectoral one fifth of total length to end of middle caudal rays; lateral line straight, extending from eye to base of caudal fin; breast naked; a series of enlarged caducous scales on median line of belly. D. XII to XV, 11 to 13; A. II, 8 to 10; V. I, 5; P. 14. Scales 9–65 to 80–17; vertebrae 19 23—42; pyloric cacea three.

The sides are straw colored or greenish yellow, with dark tessellations and marblings above and with about seven large dark blotches, which are partly confluent; the fins are barred, and there is a small spot at the base of the caudal.

The black-sided darter, or blenny darter, is found in the Great lakes region westward to Manitoba and southward to Missouri, Indiana, Kentucky and Arkansas, being specially abundant in the Ohio valley. The U. S. Fish Commission had it from Marsh creek, Point Breeze. It prefers clear streams with gravelly bottoms and is more active in its habits than most of the other darters, not concealing itself so closely under stones. It grows to the length of 4 inches. As an aquarium fish it is unsurpassed by any of its kindred, and its sudden and remarkable changes

of brilliant colors during the breeding season render it unusually attractive.

Genus COTTOGASTER Putnam

Body rather robust, little compressed; head moderate, bluntish; mouth moderate or small; the lower jaw included; premaxillaries protractile or occasionally (in s h u m a r d i) joined by a narrow frenum to the frontal region; maxillary not adherent to the preorbital; teeth on vomer; gill membranes nearly separate; scales ctenoid; the middle line of the belly anteriorly naked or with caducous scales; lateral line continuous; dorsal fins large, the second usually smaller than the first and smaller than the anal; anal spines two, the first the longer; pyloric; caeca three; vertebrae 18+20=38 (c o p e l a n d i); skull short, the frontal region not very narrow, parietals little convex transversely, sutures distinct; no supra-occipital crest. Coloration not brilliant. Size moderate.

250 Cottogaster copelandi (Jordan)

Copeland's Darter

Boleosoma tessellatum THOMPSON, Appendix Hist. Vermont, 5, 1853, not of DE KAY, N. Y. Fauna, Fishes, 20, 1842.
Rheocrypta copelandi JORDAN, Bull. 10, U. S. Nat. Mus. 9, 1877.
Cottogaster putnami JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 498, 1883.
Cottogaster copelandi JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1045, 1896.

Body rather slender and elongate, the depth being contained from five and one half to six and one half times in the length; head rather large and long, somewhat narrowed, resembling that of B o l e o s o m a. Its length is contained from three and three fourths to four and one fourth times in the length of the body. Mouth small, horizontal, subinferior; cheeks naked; opercles and neck each with few scales; throat naked; ventral plates well developed; scales moderate, strongly ctenoid; pectoral as long as head. D. X to XII–10 to 12; A. II, 8 or 9. Scales 6–44 to 56–8.

Color brownish olive; a series of rather small, horizontally oblong, black blotches along the lateral line, forming an interrupted lateral band; back tessellated; blackish streaks forward

and downward from eye; ventral fins dusky in the male; vertical fins with dusky specks; a small inklike speck at base of caudal persistent in most specimens; a black spot on anterior rays of spinous dorsal.

Length 2½ to 3 inches. Great lakes region, from Lake Champlain to Lake Huron; represented in New York waters by the subspecies C. p u t n a m i .

251 Cottogaster cheneyi Evermann & Kendall

Cottogaster cheneyi Evermann & Kendall, Bull. U. S. F. C. 1897, 129, pl. 8, fig. 8, 1898. Racket River near Norfolk, N. Y.; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2851, 1898.

Head four; depth six; eye four in head; snout four; maxillary three and one half; interorbital width five and one half. D. XI–12; A. II, 8. Scales 7-56 6. Body rather stout, heavy forward, compressed behind; head heavy; mouth moderate, slightly oblique, lower jaw included, maxillary reaching front of pupil; premaxillaries protractile; cheeks, opercles, breast, and nape entirely naked; scales of body large and strongly ctenoid; lateral line complete, straight; median line of belly naked anteriorly, with ordinary scales posteriorly; fins large; dorsals separated by a space equal to half diameter of eye, origin of spinous dorsal a little nearer origin of soft dorsal than tip of snout, its base about equal to length of head, longest dorsal spine two and one half in head, the outline of the fin gently and regularly rounded; soft dorsal higher than spinous portion, the second to 10th rays about equal in length, scarcely twice in head, the first, 11th, and 12th rays but slightly shorter than the others; anal moderate, its origin under base of third dorsal ray, the spines slender, the second a little longer than the first, whose length is three and three fourths in head, longest anal rays about two and one fifth in head; caudal lunate, the lobes more produced and pointed than usual among darters; pectorals long and pointed, the middle rays longest, about one and one sixth in head, reaching tips of ventrals; ventrals well separated, not nearly reaching vent, the longest rays one and one fourth in head. Color in alcohol, back dark brownish, covered with

irregular spots and blotches of darker; side with about eight or nine large dark spots lying on the lateral line; belly pale; top of head dark; snout black; lower jaw and throat dark; a broad black line downward from eye to throat; cheek and opercles rusty; spinous dorsal crossed by a median dark line; ventrals blue black; other fins pale, but dusted with rusty specks.

An examination of the 14 cotypes shows some variation in the species. In two examples there is a well developed frenum, rendering the premaxillaries nonprotractile, and in a third specimen the frenum is partially developed; in some individuals the origin of the spinous dorsal is exactly midway between the tip of snout and origin of soft dorsal. The females and immature males are less highly colored than the adult male described above. Length $1\frac{3}{4}$ to $2\frac{1}{4}$ inches.

This species seems most closely related to Cottogaster shumardi, from which it may be readily distinguished by the shorter snout, the naked cheeks and opercles, the smaller soft dorsal, the smaller anal and the coloration.

15 examples of this interesting darter were obtained July 18, 1894, by Evermann and Bean in the Racket river near Norfolk, St Lawrence co. N. Y. It did not seem to be very common, as only 15 examples resulted from numerous hauls of the collecting seine.

Named for A. Nelson Cheney, state fish culturist of New York in recognition of his valuable contributions to our knowledge of the food and game fishes of that state. (After Evermann and Kendall)

Genus DIPLESION Rafinesque

Body rather elongate, subterete; head very short and blunt, with tumid cheeks; the profile very convex; mouth small, inferior, horizontal; premaxillaries protractile, little movable, joined to the forehead mesially by a slight frenum; maxillary not protractile, adnate for most of its length to the fleshy skin of the preorbital; lower jaw very short; teeth in jaws strong, no teeth on vomer or palatines; gill membranes broadly con-

nected; gill rakers very short; scales moderate, rough; lateral line complete; no enlarged ventral plates; dorsal fins large, the spinous dorsal longer and lower than the second, of about 13 spines; anal smaller than second dorsal, with two strong spines; ventrals moderately separated; pectorals long, symmetric; vertebrae (b l e n n i o i d e s) 19+23=42; pyloric caeca four; frontal region of skull very narrow, ethmoid region abruptly decurved, parietal region moderately convex (less so than in E t h e o s t o m a, more so than in B o l e o s o m a); no supraoccipital crest. Coloration largely green.

252 Diplesion blennioides (Rafinesque)

Green-sided Darter

Ethcostoma (Diplesion) blennioides RAFINESQUE, Journ. de Physique, 419. 1819.

Ethcostoma blennioides BEAN, Fishes Penna. 121, 1893.

Diplesion blennioides JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 497. 1883; JORDAN & EVERMANN, Bull. 47. U. S. Nat. Mus. 1053. 1896. pl. CLXX, fig. 449, 1900.

The body is stout and long; the head moderate in size, its length contained four and one half times in the total without caudal and slightly exceeding the depth of the body; mouth small; lower jaw included within the upper; eyes large, placed high and narrowly separated by a longitudinal furrow; scales rather small except some larger ones on the belly, which are not shed; cheeks finely scaled; gill covers with large scales; nape scaly; breast naked. The males have a large anal papilla. Anal spines stout; caudal fin notched. Males have the lower pectoral rays and the ventral and anal rays enlarged and thickened. D. XIII–13; A. II, 8. Scales 65 to 78; vertebrae 42.

Color olive green; upper parts tessellated; sides with seven or eight double crossbars, each forming a Y-shaped figure, these bars sometimes joined above so as to form an undulating lateral band and clear deep green in life, and the sides speckled with orange. There is a dark bar from the eye forward and another downward, besides some olive stripes on the head. Spinous dorsal blue above with a pale margin and dark orange brown at base; soft dorsal and anal deep blue green tinged with

red; caudal greenish with faint bars. Females and young are less conspicuously colored, but in the same general pattern.

The green-sided darter extends from Pennsylvania westward to Kansas and south to Alabama. The U. S. Fish Commission had specimens from Sandy creek, North Hamlin N. Y., Aug. 20.

The species is notable for its beauty; it grows to a length of 5 inches; it is common in gravelly streams and occurs only in clear water. In habits it is similar to the Johnny darter, but it is less tenacious of life than that fish. In the aquarium it is shy and retiring, spending most of its time in the concealment of water plants or decorative rock work.

Genus BOLEOSOMA De Kay

Body moderately elongate, fusiform, but slightly translucent; head small, narrowed forward, the profile convex; mouth small, horizontal, the lower jaw included; premaxillary protractile; maxillaries not adnate to preorbital; vomerine teeth present; scales large; lateral line continuous or interrupted behind; belly with ordinary scales; gill membranes broadly or narrowly connected; dorsal spines usually nine, very slender and flexible, soft dorsal much larger than anal; anal normally with a single, short, slender spine, the first soft ray simple, but articulate; ventrals well separated; vertebrae (B. nigrum) 15+22=37; pyloric caeca three to six; frontal region of skull very short and narrow; parietal region flattish above; no supraoccipital crest. Coloration olivaceous and speckled, the males with inky black in spring; no red or blue. Size small. Very active little fishes, abounding among weeds in clear streams.

253 Boleosoma nigrum (Rafinesque)

Johnny Darter

Ethcostoma nigrum RAFINESQUE, Ichthyol. Ohien, 37, 1820; BEAN, Fishes Penna. 120, 1893.

Boleosoma maculatum AGASSIZ, Lake Superior, 305, pl. IV, fig. 3, 1850, Fort William; GÜNTHER, Cat. Fish. Brit. Mus. I, 77, 1859.

Boleosoma nigrum JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 492, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1056, 1896, pl. CLXX, fig. 450, 1900.

The body is slender, spindle-shaped. The conical head is contained slightly more than four times and the depth about five

times in the total length. The snout is somewhat decurved. Mouth small and the lower jaw included within the upper. The gill covers are scaly, cheeks naked except in occasional individuals, and the nape is usually scaled. The fins are high, but lower and smaller than in other species of Boleosoma. D. VIII to X, 10–14; A. I. 7 to 9; scales 5–44 to 55–9.

Color olivaceous; the back with brown tessellations; sides with many W-shaped blotches. The head is speckled above; in males generally black. In the breeding season the whole anterior part of the male is often black. A dark line forward from the eye and sometimes another downward. This is one of the small species, attaining a length of only 2½ inches. It is found on the bottom in clear small brooks, where it lies partly concealed by sand, and changes its colors according to its surroundings.

The Johnny darter ranges from western Pennsylvania to Missouri and Dakota. In the Great lakes region it is abundant, and it is one of the commonest darters in the streams of Ohio. It does not occur in eastern Pennsylvania. In New York it appears to occur in the Great lakes region only.

254 Boleosoma nigrum olmstedi (Storer)

Tessellated Darter

Etheostoma olmstedi Storer, Jour. Bost. Soc. Nat. Hist. 61, pl. 5, fig. 2, 1841; Hist. Fish. Mass. 30, pl. IV, fig. 1, 1867; Bean, Fishes Penna, 120, pl. 33, fig. 67, 1893.

Boleosoma olmstedi Goode & Bean, Bull. Essex Inst. XI, 19, 1879.

Boleosoma olmstedi Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 492, 1883; Bean, Bull. Am. Mus. Nat. Hist. IX, 365, 1897.

Etheostoma nigrum olmstedi Meek, Ann. N. Y. Ac. Sci. IV, 313, 1888.

Boleosoma nigrum olmstedi Evermann & Kendall, Rept. U. S. F. C. 1894, 603, 1896; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1057, 1896, pl. CLXXI, fig. 451, 1900; Eugene Smith, Proc. Linn. Soc. N. Y. 1897, 36, 1898.

Boleosoma tessellatum De Kay, N. Y. Fauna, Fishes, 20, pl. 20, fig. 57, 1842.

The head is contained four and one fourth times in total length; depth five and one fourth times. The cheeks and opercles are scaly; nape and breast naked. The lateral line is complete, with about 50 scales. D. IX, 14; A. I, 9.

The color is olivaceous; fins with many narrow bars; the back tessellated; sides with blotches and zigzag markings. Head in

spring males black. A dark streak forward from the eye and another downward.

This darter secretes itself on the bottom in small clear brooks, swimming rapidly for a short distance when alarmed. The sexes are very different in appearance, the males having higher and more brightly colored fins than the females. The males are larger than the females and in the spring are much spotted with black. The common darter, or tessellated darter, is found from Massachusetts to Georgia. It is replaced in Cayuga lake and some other regions to the southward by a black spotted variety, which differs from the common form still further in having the nape and breast closely scaled. De Kay states that it occurs in most of the fresh-water streams of the state. It is found in Lake Champlain. Evermann and Bean took it in Scioto creek, at Coopersville, in the Saranac, at Plattsburg, in the St Lawrence river, 3 miles below Ogdensburg, and in Racket river, at Norfolk. In the Lake Ontario region the U. S. Fish Commission collectors obtained it in the following localities:

Cape Vincent	June 21
Mud creek, Cape Vincent	June 25
Grenadier island	June 27
Horse island, Sackett's Harbor	June 30
Mill creek, Sackett's Harbor	July 2
Stony Island	July 2 and 3
Little Stony brook, Henderson bay	July 4
Cemetery creek, Watertown	July 5
Guffon creek, Chaumont	July 7
Chaumont river	July 10
Spring brook, Pulaski	July 24
Mouth of Salmon river, Selkirk	July 25
Mouth Little Salmon creek	July 25
Three Mile creek, Oswego	July 27
Great Sodus bay	Aug. 6
Long pond, Charlotte	Aug. 17
Sandy creek, North Hamlin	Aug. 20

According to Dr Meek it is common at each end of Cayuga lake, but is not found in the streams at the southern end above the falls. The species was obtained in small numbers by the writer in Bronx river in August, 1897. Eugene Smith has obtained it in tidal creeks where the water is impure but not saline. It is recorded from streams of Long Island.

The tessellated darter grows to the length of 3½ inches. It is a near relative of the Johnny darter, Boleosoma nigrum of Rafinesque. In captivity Eugene Smith has found it delicate, able to live only in water of low temperature and not deep unless in circulation. In balanced tanks it thrives and feeds freely on minced clam, Gammarus, and earthworms, the last to be used only occasionally.

De Kay observed it usually at the bottom of clear springs or streams, lying for a while perfectly still near the bottom, and then suddenly darting off with great velocity at its prey, a habit from which is derived its name of darter. He mentions also the name *grand-orauchee*, applied to it in New York by the descendants of the Dutch colonists, but this name is not satisfactorily explained.

The best account of the movements of the fish is given by Zadock Thompson in his *History of Vermont*. He noted its power of bending its neck and moving its head without moving the body, a very unusual faculty among fishes.

Genus ETHEOSTOMA Rafinesque

Body robust, or rather elongate, compressed; mouth terminal, or subinferior, varying in size; the lower jaw included or projecting; premaxillaries not protractile; maxillary movable; teeth rather strong, usually present on vomer and palatines; gill membranes separate or more or less broadly connected; scales moderate or small, ctenoid, top of head without scales, scales of the middle line of the belly persistent and similar to the others; lateral line well developed, nearly straight, often wanting posteriorly; fins large, with strong spines, first dorsal usually longer and larger than the second, with seven to 15 spines; anal with two strong spines, the anterior usually the

larger, the second rarely obsolete, anal fin always smaller than the soft dorsal; ventral fins more or less close together; skull narrow, the parietal region very strongly convex in cross-section, supraoccipital crest very small or wanting; lower pharyngeals very narrow; vertebrae 33 to 39, usually 15+21=36; pyloric caeca three or four; bones rather firm. Coloration various, often brilliant. As here understood, a very large genus covering a great variety of forms. Many attempts at further subdivision have been made. Intergradations of all sorts occur, and the technical characters do not always indicate the real relationship. Many of the species are excessively variable, each brook having its peculiar race.

Subgenus OLIGOCEPHALUS Girard

255 Etheostoma coeruleum Storer

Blue Darter; Rainbow Darter

Ethcostoma coerulea Storer, Proc. Bost. Soc. Nat. Hist. II, 47, 1845, Fox River, Ill.

Poecilichthys coeruleus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 517, 1883.

Etheostoma coeruleum Meek, Bull. U. S. F. C. 119, 131, 155, 1891; Bean, Fishes Penna. 125, 1893; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1088, 1896.

Body short, comparatively stout; head large; mouth moderately large, the lower jaw included within the upper. The maxilla extends to the front of the eye. The length of the head is contained three and three fourth times in the total length without the caudal, and the depth of the body four and one fourth times. Five rows of scales above the lateral line, eight rows below the lateral line, and 45 rows from head to base of caudal, nape and breast generally scaleless. D. X, 12; A. II, 7.

The body of the male is olivaceous with darker blotches on the back, 12 bars of indigo blue running obliquely downward and backward across the sides. The spaces between the bars are orange, as are also the throat, breast and cheeks. The base of the spinous dorsal is crimson, surmounted by orange and margined with blue. The soft dorsal is orange, its base and margin blue. In the female the blue and orange colors are

chiefly wanting, and the dorsal, anal and caudal are checked or barred.

The blue darter, blue Johnny, rainbow darter, or soldier fish, is found in the Ohio valley and in some parts of the Mississippi valley. It abounds in gravelly streams and ascends small brooks, but not in large numbers. The U. S. Fish Commission obtained many individuals in Marsh creek at Point Breeze N. Y. Aug. 2, and a few in Salt brook, 1½ miles above Nine Mile point, June 11, 1893.

The blue darter reaches a length of 3 inches. It is not so active as some of the other darters, but in coloration it is the most beautiful of all. One of the most interesting accounts of its habits is republished in Bulletin 47, U. S. National Museum, from the writings of Jordan and Copeland. It will follow to the surface of the water a piece of meat suspended by a thread and has been seen to catch a water insect by a swimming leg and release it several times, apparently for the mere pleasure of playing tricks.

Subgenus ETHEOSTOMA

256 Etheostoma flabellare Rafinesque

Fantail Darter

Etheostoma flabellaris RAFINESQUE, Jour. de Physique, Paris, 419, 1819.

Etheostoma linsleyi STORER, Proc. Bost. Soc. Nat. Hist. 37, 1851, Wolcott, Wayne County, N. Y.

Catonotus fasciatus GIRARD, Proc. Ac. Nat. Sci. Phila. 68, 1859, Madrid, N. Y.

Catonotus flabellatus VAILLANT, Recherches sur Etheostom. 121, 1873, with plate.

Etheostoma flabellare JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 513, 1883; MEEK, Ann. N. Y. Ac. Sci. IV, 314, 1888; BEAN, Fishes Penna. 125, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1097, 1896; EUGENE SMITH, Proc. Linn. Soc. N. Y. 1897, 37, 1898.

Body slender, elongate; head long, lower jaw strongly projecting. The species is readily recognized by its low fins, specially the spinous dorsal, and its prominent lower jaw. It runs, however, into several varieties, one of which, occurring in Indiana and northwestward, has black spots on the scales forming lateral stripes; another variety from the Cumberland river

is distinguished by its thick jaw and nearly plain coloration. In the male the spinous dorsal is one half as high as the soft dorsal. The female has higher spines than the male; the spines have fleshy tips. No scales on nape, head and breast. A large black humeral scale. The length of the head equals one fourth of the total length without caudal, and the depth one fifth. D. VIII, 12; A. II, 8. Scales 7–50–7. The lateral line ends at the middle of the length.

The general color is olivaceous, the upper parts dusky; the sides with dark streaks formed by the spots at the base of the scales. The males have dusky crossbars; the soft dorsal and caudal barred. The spinous dorsal of the male has an orange margin.

The fantail darter is found from western New York to North Carolina, and in the Ohio valley. In the Lake Ontario region the U. S. Fish Commission collectors obtained it from the following places in 1893:

Salt brook, 1½ miles above Nine Mile point	June 11
Grenadier island	June 28 and 29
Horse island, Sackett's Harbor	June 30
Mill creek	July 2
Little Stony brook, Henderson bay	July 4
Cemetery creek, Watertown	July 5
Chaumont river	July 10
Big Sandy creek, Belleville	July 12
Wart creek	July 24
Spring brook, Pulaski	July 24
Three Mile creek, Oswego	July 27
Great Sodus bay	Aug. 6
Four Mile creek, Nine Mile point, Webster	Aug. 9
Sandy creek, North Hamlin	Aug. 20
Marsh creek, Point Breeze	Aug. 21

Writing of the fishes of Cayuga lake basin, Dr Meek makes the statement that the fantail darter is found with the tessellated darter at each end of Cayuga lake; that these two

are the only species of darters in the lake, and neither of them occurs in the streams on the uplands.

Though usually considered as being limited to western New York, Eugene Smith says it is not altogether rare in the Hackensack valley streams, perhaps the easternmost locality in which it occurs.

It grows to a length of 2½ inches and abounds in clear rocky streams. It is very active and tenacious of life and is an excellent species for the aquarium.

Genus BOLEICHTHYS Girard

This genus contains small and slender species allied to those of the section Oligocephalus under Etheostoma. The lateral line is incomplete and has a slight upward curve anteriorly instead of being straight, as in all the species of Etheostoma. Top of head not scaly. Lowland streams and swamps. The species few, variable and hard to determine.

257 Boleichthys fusiformis (Girard)

Boleosoma fusiformis GIRARD, Proc. Bost. Soc. Nat. Hist. 41, 1854.

Hololepis fusiformis VAILLANT, Recherches sur Etheostom. 131, 1873, with plate.

Poecilichthys fusiformis JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 529, 1883.

Ethcostoma fusiforme EVERMANN & KENDALL, Bull. U. S. F. C. XII, 115, 1894; EUGENE SMITH, Proc. Linn. Soc. N. Y. 1897, 37, 1898.

Boleichthys fusiformis JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1101, 1896, pl. CLXXVII, fig. 469, 1900.

Body moderately elongate, strongly compressed. The depth is contained six times in the length. Head rather long and narrow. The length is one fourth that of the body. The muzzle short, decurved, shorter than eye; mouth comparatively large, terminal; maxillary reaching past front of eye; eyes large, four in head; opercular spine strong; lateral line beginning at the eye, on about 12 to 15 scales; neck scaly; belly and throat scaly. D. X–9; A. II, 7; lateral line 55.

Olivaceous, dotted with dusky points; second dorsal and anal speckled.

This little darter is recorded from Massachusetts to New Jersey and will doubtless be found in New York. It grows to the length of 2 inches.

258 Boleichthys fusiformis eos Jordan & Copeland

Boleichthys eos JORDAN & COPELAND, Proc. Ac. Nat. Sci. Phila. 46, 1877, Rock River, Wisconsin; Wisconsin River, Wisconsin; Fox River, Illinois.

Poecilichthys eos JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 520, 1883.

Boleichthys fusiformis eos JORDAN and EVERMANN, Bull. 47, U. S. Nat. Mus. 1102, 1896.

Body elongate, slender, somewhat compressed, specially behind, rather heavy forward, with very long and slender caudal peduncle; head long, rounded in front; mouth small, little oblique, the upper jaw a very little the longer; dorsal fins high, about equal; caudal truncate; cheeks, opercles, and neck closely scaled; breast naked, or with a median series of small scales; lateral line developed on 22 to 26 scales. Head one fourth of total length without caudal; depth $\frac{3}{16}$. D. IX–11; A. II, 7; lateral line 58.

Color dark olive, with darker markings; 10 or 12 dark dorsal spots or bars, and as many short dark blue bars across the lateral line nearly opposite the dorsal bars, but not continuous with them; the interspaces between these bars, as well as most of the ventral region, bright crimson in the males, nearly plain in the females; lower parts of the sides, cheeks, etc. with various sharply defined but irregular black markings; second dorsal, caudal, and pectorals strongly marked with wavy bands; first dorsal bright blue in the males, with a broad median band of crimson, speckled in the females; top of head dark; black streaks downward and forward from eye.

The describers of the species recorded its distribution from Indiana to Minnesota; abundant in clear cold streams. It grows to the length of $2\frac{1}{2}$ inches, and is one of the prettiest of the darters. Specimens were obtained for the U. S. Fish Commission in Mud creek, Cape Vincent N. Y. June 25, the species being abundant there, at Grenadier island, June 27, and in Guffon creek, Chaumont N. Y. July 7.

Family SERRANIDAE

Sea Basses

Genus ROCCUS Mitchill

Base of tongue with one or two patches of teeth; anal spines graduated; dorsal fins entirely separate; anal rays III, 11 or 12; supraoccipital crest scarcely widened above; lower jaw projecting. Vertebrae 12+13=25. Otherwise as in Morone, the body more elongate, the scales smoother, and the fins more slender than in Morone. Species all American, valued as food fishes. In both Roccus and Morone, the antrorse preopercular spines (characteristic of the European genus or subgenus Dicentrarchus) are wanting.

259 Roccus chrysops (Rafinesque)

White Bass

Perca chrysops RAFINESQUE, Ichthyol. Ohien. 22, 1820.

Labrax albidus DE KAY, N. Y. Fauna, Fishes, 13, pl. 51, fig. 165, 1842, Buffalo.

Labrax notatus RICHARDSON, Fauna Bor.-Amer. III, 8, 1836; GÜNTHER, Cat. Fish. Brit. Mus. I, 67, 1859.

Roccus chrysops GILL, Rept. Capt. Simpson's Surv. Great Basin Utah, 391, pl. 1, fig. 1-7, 1876; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 529, 1883; BEAN, Fishes Penna. 132, pl. 34, fig. 71, 1893; Bull. Am. Mus. Nat. Hist. IX, 365, 1897; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1132, 1896, pl. CLXXX, fig. 477, 1900; EUGENE SMITH, Proc. Linn. Soc. N. Y. 1897, 38, 1898.

The white bass has the body oblong, elevated and compressed; its depth contained two and one half times in the total length without caudal, the length of the head about three and one third times in this length; head subconical, depressed over eye; mouth moderate, the maxillary reaching to below middle of eye; length of eye almost equal to length of snout; villiform teeth in bands on jaws, palatines, vomer and tongue; the dorsal outline is much curved, the fins well separated.

D. IX, I, 14; A. III, 11 to 12. Scales 8–60–13. General color silvery, tinged with golden on sides; eight or more blackish longitudinal streaks on sides, those below more or less interrupted.

The following measurements were taken from a specimen obtained by Mr James Annin jr, in Oneida lake, Sep. 4, 1896.

	Inches
Extreme length	$12\frac{1}{4}$
Length to end of middle caudal rays	$11\frac{1}{2}$
Length to end of scales	10
Depth of body	4
Least depth of caudal peduncle	$1\frac{3}{8}$
Length of head	3
Length of snout	$\frac{5}{8}$
Diameter of eye	$\frac{9}{16}$
Length of fourth dorsal spine	$1\frac{3}{8}$
Length of second dorsal ray	$1\frac{3}{4}$
Length of second anal ray	$1\frac{3}{4}$

Weight, $16\frac{1}{2}$ ounces.

The white bass is sometimes called striped bass, and is probably the silver bass of Canada. Its center of abundance is the Great lakes region, but it is also widely distributed over the Ohio and Mississippi valleys. In Pennsylvania the species is found in Lake Erie and in the tributaries of the Ohio river. The U. S. Fish Commission secured three specimens at Horse island, Sacketts Harbor N. Y., June 30. The New Jersey Fish Commission has introduced the fish into Greenwood lake.

The white bass weighs from 1 to 3 pounds, and its flesh is considered almost if not equally as good as that of the black bass. It prefers the deeper parts of rivers and thrives best in lakes and ponds. In April and May they leave the deeper waters and go in near shore or to the mouths of rivers where they spawn. The spawning period is in May and June.

The white bass feeds upon minnows, crawfish and other freshwater crustaceans, also minute mollusks or shellfish, and it is said to devour many young whitefish upon the spawning grounds of that species.

It is a game fish and affords good sport to the angler.

260 Roccus lineatus (Bloch)

Striped Bass; Rockfish

Sciaena lineata Bloch, Ichthyol. IX, 53, pl. 305, 1792.

Perca septentrionalis Bloch & Schneider, Syst. Ichth. 90, pl. 70, 1801, New York.

Roccus striatus Mitchill, Rep. Fish. N. Y. 25, 1814.

Perca mitchilli Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 413, pl. III, fig. 4, 1815.

Perca mitchilli alternata Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 415, 1815.

Perca mitchilli interrupta Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 415, 1815.

Labrax lineatus De Kay, N. Y. Fauna, Fishes, 7, pl. 1, fig. 3, 1842; Günther, Cat. Fish. Brit. Mus. I, 64, 1859; Storer, Hist. Fish. Mass. 6, pl. I, fig. 4, 1867.

Roccus lineatus Gill, Ichth. Rep. Capt. Simpson's Expl. Great Basin Utah, 391, 1876; Goode, Fish & Fish. Ind. U. S. I, 425, pl. 170, 1884; Bean, 19th Rep. Comm. Fish. N. Y. 267, pl. XVIII, fig. 22, 1890; Fishes Penna. 131, color pl. 14, 1893; Bull. Am. Mus. Nat. Hist. IX, 365, 1897; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1132, 1896, pl. CLXXX, fig. 478, 1900; Eugene Smith, Proc. Linn. Soc. N. Y. 1897, 38, 1898; Mearns, Bull. Am. Mus. Nat. Hist. X, 321, 1898; H. M. Smith, Bull. U. S. F. C. for 1897, 99, 1898; Bean, 52d Ann. Rep. N. Y. State Mus. 105, 1900.

The genus Roccus, to which the striped bass belongs, has two patches of small teeth on the base of the tongue, the anal spines increasing regularly in size backward, the lower jaw much longer than the upper, the scales on the cheeks nearly smooth along their margin and the dorsal fins separated by a narrow interspace. The body is moderately elongate and rather stout; the caudal peduncle is slender. The greatest depth of the body is two sevenths of the total length without caudal and equals length of head. Eye small, one half as long as the snout and one sixth to one eighth the length of the head. The eyes are placed near the top of the head; the maxilla reaches to below the middle of the eye. The anal spines are slender, the third longest, about one fifth length of head. The fourth and fifth dorsal spines are longest, about two fifths length of head. Pectoral a little longer than ventral, one half length of head.

D. IX, I, 11 to 12; A. III, 10 to 11. Scales 7–65–19.

Sides greenish above, silvery below, sometimes with a brassy lustre and marked by seven or eight longitudinal streaks none of

which are half as wide as the eye, one of them passing along the lateral line; the lowermost stripe is somewhat below the middle of the depth.

In the southern United States from New Jersey to Florida the striped bass is known as the rock or rockfish. In the northern states the name striped bass is more generally used than the other, specially along the coast. In the Delaware, Susquehanna and Potomac rivers it is called rockfish. Greenhead and squid hound are names applied to large individuals found in the sea in New England waters. One of the old names of the fish is streaked bass.

Rockfish and striped bass, according to Schoepff (1787), are among the early New York names for this highly prized species. Dr Mitchill (1814) calls it Mitchill's perch, striped basse and rockfish. De Kay describes it as the striped sea bass. Streaked bass is another name in use in 1815, and a very interesting account of the fish under this name is published by Dr James Mease in the first volume of the *Transactions of the Literary and Philosophical Society of New York*. Dr Mease in this article states that rockfish weighing from 25 pounds to 60 pounds are called greenheads. At the time of his writing the fishing ground for the Philadelphia and New York markets was between Long Branch and Cranberry inlet, an extent of about thirty miles, and the great places of winter resort were Motetecunk, 50 miles from Long Branch, and the rivers of Elk and Egg Harbor.

At the time of Dr Mitchill's report the greatest run occurred late in the fall, and great hauls were made during the coldest season, including some very large fish. He saw, however, a dozen at a time weighing 50 pounds each in New York market during very mild weather in early October.

The range of the striped bass or rockfish includes the entire Atlantic coast from the Gulf of St Lawrence to the Gulf of Mexico, the fish entering rivers and ascending them long distances. In the Alabama river this fish is known to be taken every year and some large individuals have been obtained from that stream. It has been captured also in the lower Mississippi.

It is very abundant in the great bays and sounds from North Carolina to Cape Cod. In Albemarle sound many large individuals are said to occur. In the St John's river, Florida, according to Dr Goode, the fish is rather rare. In the vicinity of Pensacola the late Silas Stearns occasionally obtained a specimen of the fish.

The striped bass has been introduced into California and has now become fairly acclimated there. In the Delaware and Susquehanna rivers this is one of the common fishes and it is one of the most highly esteemed.

This is a permanent resident of Gravesend bay, but the hight of the fishery occurs from October 10 to November 10. Large fish, up to 45 pounds, are caught in May, but the fall fish range from 9 inches to 24 inches in length. In Great South bay the writer has obtained specimens at Blue Point cove, Great river, Nichols's point, and off Widow's creek. A great haul was made on Lone Hill Middleground about the middle of October, 1901. The fish remains in some of the tributaries of Great South bay throughout the year. According to Dr Mearns the species is taken in great numbers in nets set through the ice of the Hudson in winter, and in drift nets by shad fishermen in spring. Large individuals of 60 pounds and upward are sometimes caught in the winter and early spring. He once took a specimen a little above the estuary of Poplopen's creek, in fresh water.

At Woods Hole Mass. the fish is not common, and apparently does not spawn: it arrives about May 1 and leaves about November 1; in size it ranges from ½ pound to 65 pounds.

This fish lives in the sea or in brackish or fresh water indifferently and it has been successfully kept in artificial ponds. In cold northern waters its becomes icebound occasionally and is said to hibernate. It prefers cold water, is carnivorous and predaceous, feeding upon small fishes in the streams, consuming specially large quantities of the alewife or river herring and the young of the shad. In the shallow bays along the coasts its food consists of killifish, silversides, anchovies, lant and other small fishes, besides crabs, squid, clams, mussels and other

marine invertebrates. Its movements while feeding depend greatly on the tides. It is to be found frequently at the mouths of small creeks and in tideways, where it lies in wait for the large schools of small fishes, which constitute its food.

The largest striped bass recorded was said to weigh 112 pounds. At Avoca, North Carolina, Dr Capehart took a striped bass weighing 95 pounds. It reaches a length of four and one half or five feet.

Spawning takes place from April to June, either in the rivers or in the brackish waters of bays and sounds. Eggs have been hatched artificially in May on Albemarle sound. Dr Capehart took a 58 pound spawning fish April 22, 1891. The eggs are smaller than those of the shad and after fertilization they increase greatly in size and become light green in color. This 58 pound fish probably contained more than one half million eggs. Dr Abbott has found the young an inch long in the Delaware the second week in June and by the middle of October some of these had grown to a length of 4½ inches. The striped bass has been kept in a small pool of fresh water and fed upon crabs and oysters increasing in about eleven months from 6 inches in length to 20 inches. In the aquarium the species is hardy and grows rapidly; it can be kept in good condition almost indefinitely. In a Rhode Island pond it is stated that bass weighing ½ pound to 1 pound in June had reached a weight of six pounds in the following October.

In fresh water, salted eel tail is a favorite bait for taking striped bass, and the spoon or spinner is also a good lure, but live minnows are preferred to all other baits. For surf fishing shedder crab well fastened to the hook is a very killing bait.

Genus MORONE Mitchill

Body rather short and deep, compressed; maxillary broad, naked, without supplemental bone; teeth subequal; lower jaw scarcely projecting; no canines; no movable teeth; base of tongue without teeth; edge of tongue with linear patches of teeth. Lower margin of preopercle finely serrate or entire, the serrae not greatly increased in size toward the angle, and none

of them developed as antrorse hooks. Spines strong, 10 in the dorsal fin; dorsal fins more or less connected by membrane; second anal spine much enlarged, not shorter than third; anal rays III, eight or nine. Vertebrae 12+13=25. Scales rather large, ctenoid; top of head scaly; lateral line little arched. Ventrals inserted well behind pectorals. Two known species, both American.

261 **Morone americana** (Gmelin)

White Perch

Perca americana Gmelin, L. Syst. Nat. I, III, 1308, 1788, New York.

Morone Rufa Mitchill, Rep. Fish. N. Y. 18, 1814, New York.

Morone Pallida Mitchill, Rep. Fish. N. Y. 18, 1814, New York.

Bodianus rufus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 420, 1815.

Labrax rufus De Kay, N. Y. Fauna, Fishes, 9, pl. 3, fig. 7, 1842; Günther, Cat. Fish. Brit. Mus. I, 65, 1859.

Labrax pallidus De Kay, N. Y. Fauna, Fishes, 11, pl. 1, fig. 2, 1842; Günther, Cat. Fish. Brit. Mus. I, 67, 1859.

Labrax nigricans De Kay, N. Y. Fauna, Fishes, 12, pl. 50, fig. 160, 1842.

Roccus americanus Bean, 19th Rep. Comm. Fish. N. Y. 268, pl. XIX, fig. 23, 1890.

Morone americana Gill, Ichth. Rept. Capt. Simpson's Surv. Great Basin Utah, 397, 1876; Bean, Fishes Penna. 133, pl. 15, 1893; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1134, 1896, pl. CLXXXI, fig. 479, 1900; Bean, Bull. Am. Mus. Nat. Hist. IX, 366, 1897; Mearns, Bull. Am. Mus. Nat. Hist. X, 321, 1898; Eugene Smith, Proc. Linn. Soc. N. Y. 1897, 39, 1898; H. M. Smith, Bull. U. S. F. C. 1897, 99, 1898; Bean, 52d Ann. Rept. N. Y. State Mus. 105, 1900.

The genus Morone of Gill differs from Roccus in having the dorsals joined, the spines strong, the anal with 10 soft rays, its spines not graduated, the jaws subequal and base of the tongue toothless. It includes the common white perch and the yellow bass.

The white perch has an oblong body, with the back convex, mouth moderate, the maxillary reaching a little beyond the front of the eye; the eye is nearly as long as the snout, and is contained five and one half times in the length of the head; the head is about one third of total without caudal; the depth of body is contained two and two thirds times in total without caudal; the fourth anal spine is the longest, two fifths length of head; the second is stouter and slightly shorter than the third, its length one third that of head.

D. IX, I, 12; A. III, 10. Scales 7–51–11. The dorsal fins are separated by a very deep notch, but connected by membrane; upper parts grayish or greenish; sides silvery; young individuals have pale, longitudinal streaks.

This is the perch or river perch of Schoepff, which he records as an inhabitant of the coasts of New York and Long Island, in and at the mouths of fresh-water streams. Dr Mitchill (1815) gives it the name of red perch, and states that when not in the breeding season it is called black perch because its colors are browner and darker. De Kay describes it, in the *Fishes of New York*, as the ruddy bass. In Great Egg Harbor bay individuals taken from salt water are sometimes called yellow perch or peerch.

The species is found from Nova Scotia to South Carolina, and inhabits both salt and fresh water. Mitchill saw specimens 14 inches long and nearly 5 inches deep, from Quag, Long Island. There is an important winter fishery for the white perch at Bellport. It is taken in seines and gillnets. The writer has occasionally found this species in various parts of Great South bay, for example, at Smith's point, Whale House Hole, Swan river; also in the east end of Shinnecock bay, in the fresh water of Head of Creek, near Southampton. The fishermen affirm that when its feeding grounds are disturbed by seining the fish suddenly leave the locality. The white perch is never plentiful in Gravesend bay; it is abundant in fresh-water lakes of Central park, New York, and Prospect park, Brooklyn. Near Montauk, Long Island, the species is abundant and reaches a large size. Eugene Smith has found it common in brackish waters near New York, where it occurs all the year; he had it also from fresh water. Mearns states that it remains in the Hudson throughout the year and is taken in abundance in winter in nets set through the ice. In Oscawana lake, Putnam county, individuals weighing 2 or 3 pounds were reported to him.

In the vicinity of Woods Hole Mass. the fish is abundant in fresh-water ponds connected with salt water.

It is said that the white perch formerly extended south to Florida and the Gulf of Mexico, but this is discredited by com-

petent observers. The perch of Lake Ponchartrain is very likely the species now known in many portions of the western states as the fresh-water drum, *Aplodinotus grunniens*.

The average length of the white perch is about 9 inches and its weight ½ pound or less, but numerous specimens measuring 14 inches and weighing 2 pounds or more have been taken, specially in New England waters.

At the time of Dr Mitchill's writing the species was a favorite in New York markets, and it is now one of the best known species though probably not ranking among the choicest kinds.

Thaddeus Norris was one of the most earnest supporters of the white perch, and has published interesting observations concerning its habits. Comparatively little, however, is known about its life. It is an associate of the striped bass, and, according to Dr Abbott, resembles this species in its feeding habits. It differs from the striped bass in its tendency to seek warm waters.

The white perch is a lover of brackish water, and may be found in tidal creeks in vast numbers associated with mummichogs, silversides and eels, feeding upon shrimp and minnows. Spawning takes place in May and June. According to Professor John A. Ryder, the egg of the white perch is very adhesive, and on this account is troublesome to hatch artificially. In the experiments made by him the eggs were taken upon cotton yarn, which was drawn up through a funnel into which the eggs and milt had been squeezed from the spawning fish. The cord, covered with the adhering eggs, was then wrapped upon a wooden reel and sent under cover of damp cloths to the central station, where they arrived in fine condition, almost every egg being impregnated. This system was devised and carried out under the superintendence of Col. M. McDonald. After reaching the central station the cotton cord with the adhering eggs was cut into lengths of 10 or 12 inches and suspended in the glass hatching jars. The development was soon interfered with by the growth of fungus. When the wooden reel with the ad-

hering eggs was introduced into a wide aquarium fungus also attacked the eggs as before but the results were somewhat more favorable. With the water at 58° to 60° F. the eggs hatched out in 6 days.

The white perch congregates in large schools and is one of the freest biters among fishes. The shrimp is one of the best baits, though worms, sturgeon eggs, minnows and strips of cut fish with silvery skin are equally effective. Dr Abbott has known as many as 20 dozen to be taken with a line in a few hours, and Spangler mentions catches of six or seven hundred in a day by two rods, the fish ranging in weight from ¾ to 1¼ pounds.

Eugene Smith, on several occasions, found a long, green, brackish-water alga (Enteromorpha) in stomachs of white perch, indicating that they sometimes eat vegetable matter, though perhaps only for the minute organisms found upon it.

In captivity the fish is very susceptible to fungus attacks, but the parasite is readily killed by changing the water supply from salt to fresh, or vice versa.

Genus POLYPRION Cuvier

Body robust, moderately elevated, not much compressed, covered with small, firm, ctenoid scales which extend on the bases of the vertical fins. Lateral line complete, partly concealed under adjacent scales, the tubes covering the whole length of the scale. Mouth large, the lower jaw projecting; maxillary with supplemental bone. Teeth in broad, villiform bands on jaws, vomer, palatines, and tongue; no canine teeth. Head scaly. Preopercle serrate; orbital region with spinous projections; opercle with a strong spine and with a strong, rough, bony longitudinal ridge; gill membranes separate; gill rakers long, few. Dorsal fin continuous, low, with 11 strong spines and 11 or 12 rays, the spinous portion longest; caudal rounded; anal short, with three spines, the third the longest; ventrals large, inserted below, little behind pectoral; caudal rounded or truncate; pectorals short, unsymmetrical, of 18 or 19 rays, the

upper longest. Spines of anal and ventrals somewhat serrate on the anterior edge. Vertebrae 13-14 27. Pyloric caeca about seventy. Branchiostegals seven. Posterior processes of premaxillaries not reaching frontals; parietal and supraocular crests not extending between postfrontal processes; supraoccipital crest strong, but not produced forward on cranium. Species inhabiting deep waters in the warm seas, reaching a very great size. The one is confined to the coasts of Southern Europe and neighboring waters; the other (Polyprion oxygeneios) is recorded from Juan Fernandez and about New Zealand.

262 Polyprion americanus (Bloch & Schneider)

Wreckfish; Stone Bass; Cernier

?*Amphiprion americanus* Bloch & Schneider, Syst. Ichth. 205, pl. XLVII, 1801.

Polyprion cernium Cuvier, in Valenciennes, Mém. du Mus. d'Hist. Nat. XI, 265, pl. XVII, 1824; Cuvier & Valenciennes, Hist. Nat. Poiss. III, 21, pl. 42, 1829; Günther, Cat. Fish. Brit. Mus. I, 169, 1859.

Polyprion oxygenius Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 532, 1883.

Polyprion americanus Jordan, Cat. Fish. N. A. 83, 1885; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1139, 1896, pl. CLXXXI, fig. 480, 480a, skull, 1900.

Body robust, moderately elevated, the depth being contained from two and two thirds to three and one half times in the length; mouth large, the maxillary reaching to posterior border of eyes; teeth in villiform bands on jaws, vomer, palatines, and tongue; supraocular region, supraclavicle, post-temporal, preopercle, and a ridge on opercle spinigerous; dorsal fin low with 11 strong spines; caudal rounded; anal spines short, serrate anteriorly, the third much the longest; ventrals large; pectorals short. The length of the head is contained three times in the length of the body. D. XI, 12; A. III, 8. Color grayish brown, the caudal edged with white; young clouded with light and dark. This large fish is not uncommon off the coast of Europe in the deep waters of 300 fathoms or more, the young only swimming near the surface, specially southward. It is said to live most abundantly about wrecks; hence the common name of wreck-

fish. It reaches a length of 5 or 6 feet. A single young specimen has been taken in deep waters of the Gulf stream by the U. S. Fish Commission, but there is no other record from America.

Genus EPINEPHELUS Bloch

Body stout, compressed, covered with small, ctenoid scales, which are often somewhat embedded in the skin; scales of the lateral line triangular, cycloid; soft parts of the vertical fins generally more or less scaly. Cranium narrow above. Parietal crests not produced on frontals which are without transverse ridge posteriorly; frontals with a process or knob on each side behind interorbital area; premaxillary processes fitting into a notch or cavity on the anterior end of the frontals. Preopercle moderately serrate behind, its lower limb entire, without distinct antrorse spine; opercle with two strong spines. Nostrils well separated. Mouth large; maxillary large, with a well-developed supplemental bone, its surface usually with small scales. Canine teeth few, large in the front of the jaws; enlarged teeth of the inner series of each jaw depressible. Gill rakers short and rather few. Dorsal spines usually 11, rarely 10, not filamentous, the last ones somewhat shorter than the middle ones. Anal spines three, the second usually the larger; the number of soft rays seven to nine. Caudal fin rounded or lunate. Pyloric caeca few (usually 10–20). Pectorals rounded, shortish, nearly symmetric, of 15 to 20 rays. Ventrals moderate, inserted below pectorals, close together, each with a strong spine. Species very numerous, most of them of large size, abounding in all the tropical seas, where they are valuable food fishes. This is the largest and most important genus of the Serranidae, and its species are most widely distributed.

263 **Epinephelus niveatus** (Cuv. & Val.)

Spotted Grouper; Snowy Grouper

Serranus niveatus CUVIER & VALENCIENNES, Hist. Nat. Poiss. II, 380, 1828; GÜNTHER, Cat. Fish. Brit. Mus. I, 130, 1859.

Serranus margaritifer GÜNTHER, op. cit. 131, 1859.

Hyporthodus flavicauda GILL, Proc. Ac. Nat. Sci. Phila. 98, 1861, young, Newport R. I.

Epinephelus nivcatus Poey, Syn. Pisc. Cubens. 286, 1868; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 541, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1156, 1896; H. M. Smith, Bull. U. S. F. C. 1897, 99, 1898; op. cit. 1901, 32, 1901.

Body oblong, compressed, the back elevated; the anterior profile somewhat convex; the snout short, rather sharp, its length contained three and three fourths times in length of head. Head three sevenths and depth of body about one third of total length without caudal. Mouth large, the maxillary extending to below posterior margin of eye, its length one half length of head. Canines rather strong, specially in upper jaw. Lower jaw considerably projecting. Eye rather large. Interorbital space flattish, its width contained seven and one half times in length of head and twice in length of snout. Preopercle with a salient angle armed with stronger teeth, a slight notch above the angle. Gill rakers 15 below the angle of first arch, the longest as long as the gill fringes. Dorsal spines rather high, the fourth contained about two and three fifths times in length of head; soft dorsal of moderate hight; caudal truncate, one half as long as the head; anal moderate, its second spine about as long as the third, three eighths as long as the head, its longest soft ray three sevenths as long as the head. Pectorals not reaching to the tips of the long ventrals, about one half as long as the head. Ventrals about as long as pectorals, nearly reaching vent. D. XI (rarely X), 14 or 15; A. III, 9; scales 18–115 to 120–50; pores of lateral line 67 to 75.

Color of young in alcohol: brown, with round whitish spots on the body, rather smaller than pupil, regularly arranged in vertical and horizontal series, about five in horizontal and four in vertical row; these rows sometimes show irregularities; no distinct spots on breast; a very large black blotch on upper part of caudal peduncle extending to below lateral line; a dark mustache above edge of maxillary; fins nearly plain, probably yellowish in life, the dorsal with a median row of dusky spots on the membranes. Some specimens lack the saddlelike blotch on the tail, but the pearly spots on the side are persistent in all.

The spotted grouper occurs in the West Indies and south to Brazil frequently straying northward in the Gulf Stream as far as Cape Cod. A young specimen was taken many years ago at Newport R. I. and others have been secured in Rhode Island waters. At Woods Hole Mass. according to Dr H. M. Smith, it is not rare. First reported in 1895, when as many as 10 or 12 specimens were obtained in the Woods Hole region. In 1897 several others were taken in summer and fall; one was caught August 7 in a dredge in Vineyard Sound in 6 fathoms of water and in November several were taken in a fyke net in Great Harbor. All have been of small size (3 inches or less), and most of them have been brought up in lobster pots. Dr Smith also recorded 35 specimens, taken in Katama bay on nine occasions between August 15 and October 26, 1900.

The example described by Dr Günther, from South America, under the name Serranus margaritifer was 11½ inches long. The colors of his specimen were as follows:

The ground color is reddish olive, lighter on the belly; on each side of the body are four series of pearl-colored spots, each occupying the place of five or six scales. The uppermost series reaches from the occiput along the base of the dorsal fin to the black blotch of the tail, and is composed of eight spots; the second, following the lateral line, of six; the third, from the angle of operculum, of four; and the fourth, from the base of the pectorals, of five. There is a blackish streak behind the maxillary bone. The black blotch on the tail occupies nearly the whole space between the dorsal and caudal fins and between the two lateral lines. The fins are nearly unicolored; a single pearl-colored spot is to be seen on the seventh spine and on the ventral fins; the anal has a whitish edge; ventrals blackish, with whitish lateral margin; pectorals uniform yellowish.

Genus CENTROPRISTES Cuvier

Body robust, somewhat compressed, covered with rather large ctenoid scales. Mouth large, formed as in Serranus and Paralabrax, the canines small. Tongue smooth. Preopercle serrate, the lower teeth somewhat antrorse. Gill rakers rather long and slender. Supraoccipital and parietals with strong crests extending forward to between postfrontal processes; frontals posteriorly with an angular transverse ridge in front of

supraoccipital connecting the parietal crests; posterior processes of premaxillaries not reaching frontals. The characteristic smooth area on top of cranium very short and small. Dorsal short, its rays X, 11; anal rays III, 7; caudal usually three lobed or double concave; the canines very weak and the top of the head naked. The ventrals as in Prionodes, close together and inserted in advance of axil of pectoral; pectoral with 19 rays, its upper half truncate behind. The three species of Centropristes are closely related.

264 Centropristes striatus (Linnaeus)

Sea Bass; Blackfish

Labrus striatus LINNAEUS, Syst. Nat. ed. X, 285, 1758, America.
Perca atraria LINNAEUS, Syst. Nat. ed. XII, 485, 1766, Carolina.
Perca varia MITCHILL, Rep. Fish. N. Y. 11, 1814; Trans. Lit. & Phil. Soc. N. Y. I, 415, pl. 3, fig. 6, 1815, New York.
Centropristes nigricans CUVIER & VALENCIENNES, Hist. Nat. Poiss. III, 37, pl. 44, 1829, New York; DE KAY, N. Y. Fauna, Fishes, 24, pl. 2, fig. 6, 1842; BEAN, 19th Rep. Comm. Fish. N. Y. 266, pl. XVII, fig. 21, 1890.
Centropristes atrarius GUNTHER, Cat. Fish. Brit. Mus. I, 86, 1859; GOODE & BEAN, Bull. Essex Inst. XI, 19, 1879.
Serranus atrarius JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 533, 1883.
Serranus nigrescens JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 917, 1883.
Centropristes striatus JORDAN & EIGENMANN, Bull. U. S. F. C. VIII, 391, pl. 64, 1890; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1199, 1896, pl. CXC, fig. 500, 1900; BEAN, Bull. Am. Mus. Nat. Hist. IX, 366, 1897; H. M. SMITH, Bull. U. S. F. C. 1897, 100, 1898; BEAN, 52d Ann. Rep. N. Y. State Mus. 105, 1900; SHERWOOD & EDWARDS, Bull. U. S. F. C. 1901, 28, 1901.

Body ovate, robust, the back somewhat elevated; axis of body below the middle of the depth. The length of the body is three times its depth and two and three fourths times the length of the head. Head large, thick, little compressed, somewhat pointed; top of head naked; cheeks and opercles scaly; scales on cheeks in about 11 rows. Mouth oblique, low, rather large, the premaxillary below the level of the eye; lower jaw prominent; maxillary broad, its upper edge anteriorly slipping under the edge of the preorbital, which is nearly as wide as the eye. Eye large, wider than interorbital space, less than snout, 4¼ in head. Gill rakers long, about 18 below the angle. Canines very small, scarcely differentiated. Teeth all fixed, the

bands rather broader than usual. Dorsal spines rather strong, not filamentous, the middle ones rather higher than the posterior, which are considerably lower than the soft rays, the highest spine as long as from snout to middle of eye. Anal short and high, its spines graduated. Pectoral very long, $1\frac{1}{4}$ in head, reaching vent. Ventrals long, nearly reaching vent, inserted below front of the base of pectorals. Caudal slightly double concave; fins little scaly except at base; a rudimentary groove at base of spinous dorsal, over which scales do not pass. Length 12 inches. D. X, 11; A. III, 7; Lat. l. 50 to 55 pores; caeca 4–7.

Dusky brown or black, adults often bluish; more or less mottled, with traces of pale longitudinal streaks along the rows of scales; young greenish, often with a dark lateral band, sometimes broken up forming crossbars; dorsal fin with several series of elongate, whitish spots, forming interrupted lines; other fins dusky, mottled.

The sea bass is the Perca varia of Mitchill, *Fish. N. Y.* p. 415. Common names given by this author are sea basse, blackharry, hanna hills and bluefish. Schoepff (1787) gives the New York name as blackfish; De Kay has it as the black sea bass, also black bass and blackfish. Dr Storer records the Massachusetts name of black perch. Other common names on the coast are black will (Middle States) and rock bass (New Bedford).

The sea bass is found from Vineyard sound southward, its southern limit not being accurately determined, but probably not extending below Cape Hatteras. The southern form, which was described by Linnaeus from South Carolina, may be distinct from the northern, and if so it should be designated by the Linnaean name atraria.

The northern form has been found occasionally north of Cape Cod, at Nahant, Salem, and Beverly bar. Dr Smith reported it as very common at Woods Hole in 1898, where it arrives in May and departs from the inshore waters about October 1, being most abundant from July to September. It spawns there in June. The young are first seen about August 1. The maximum weight is 6 pounds. In 1900 the sea bass was said to be remarkably scarce

at Woods Hole. According to the observers of the Fish Commission this fish is decreasing rapidly in numbers. Handlining, even on the spawning grounds off Hyannis was remarkably poor and young fish were less numerous than usual. As a rule the first adults appear in their seasonal migration during the first or second week in May, when the water has reached a temperature of 48° to 50° F. However, in spite of the cold of 1900, they appeared at Cuttyhunk and Menemsha Bight on April 28—with one exception the earliest arrival recorded in 25 years. Formerly the young were abundant everywhere, but at present they are restricted to a few localities—Katama bay, Quisset harbor, and Wareham river. The first fry were seined July 31 and measured ¾ of an inch in length. On October 20 young fish 2 to 3 inches long were very plentiful in Katama bay.

In 1884 the writer obtained young examples only, and these in moderate numbers, at Fire Island near the end of September. In 1890 a few individuals were observed in a net at Islip. In 1898, adults were taken in abundance offshore at Southampton in August and halfgrown specimens were secured from a pound at Islip. Young sea bass were rather common at Point of Woods, Great South bay, Clam Pond Cove, Fire Island inlet, Oak Island beach, and Nichols's Point. In the summer of 1901, early July to the middle of October, only a few young individuals were taken, and these were secured in eel pots off Widows' Creek, Great South bay.

The sea bass makes its appearance in Gravesend bay in May. It is not abundant. The young in October are found in the eel grass, measuring from 1½ to 2 inches in length. The species is well adapted to life in aquarium tanks during all but the coldest months.

The sea bass is distinguished for its voracity and its persistent biting. The young are found in the channels of shallow bays and about wharves and landings. Large fish frequent the offshore banks where the bottom is rocky. A famous locality is Five Fathom bank, off the coast of New Jersey. In the shallow waters of Great Egg Harbor bay hundreds of small-sized sea

bass may be taken in a day, and it is difficult to find a locality which is free from them. Their food consists of shrimp, crabs, sea worms, squid, small fishes and all other animals of suitable size. The species is sluggish in its habits and resembles the tautog in its tendency to hide in rock crevices. The sea bass breeds in the summer months and the young grow rapidly. The eggs have been hatched artificially, and when it becomes desirable the fry can be produced in vast quantities. The eggs are $\frac{1}{16}$ inch in diameter and hatch in 5 days in water at the temperature of 59° or 60° F. At Woods Hole Mass. they are deposited in June.

This is a valuable food fish, reaching a length of 18 inches and the weight of 6 pounds.

Genus DULES Cuvier

This genus is close to Prionodes, from which it differs in the possession of but six branchiostegals, and in the truncate form of the caudal fin. In one species the third dorsal spine is prolonged in a whiplike spine. Three American species.

265 **Dules auriga** (Cuv. & Val.)

Coachman

Dules auriga Cuvier & Valenciennes, Hist. Nat. Poiss. III. 112, pl. 51, 1829. Brazil; De Kay, N. Y. Fauna, Fishes, 34, pl. 19, fig. 54, 1842. New York harbor, perhaps erroneously so ascribed, but given on the authority of Mr Hamilton; Günther, Cat. Fish. Brit. Mus. I. 266, 1859; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 542, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1220, 1896.

Serranus brasiliensis Jordan, Proc. U. S. Nat. Mus. 533, 1886.

Serranus flaviventris Jordan & Eigenmann, Bull. U. S. F. C. VIII. 406, 1890.

Body rather deep and compressed, its depth contained two and four fifths times in total length without caudal, and equal to the length of the head; anterior profile steep and nearly straight; mouth rather small, the lower jaw projecting; preorbital rather narrow, as broad as pupil; eye two sevenths as long as the head; snout one fourth length of head; top of head naked; the frontal area large and well defined, broader than long; occipital crest low and short, shorter than the frontal area; teeth small, with no marked canines; length of maxillary five twelfths length of head; gill rakers short and slender, nine

developed below the angle and from three to five rudiments, scales large, those above in series parallel with the lateral line; scales on breast small. Third dorsal spine extremely long, reaching beyond middle of soft dorsal; other spines all short and even; soft dorsal moderate, a little scaly at base; dorsal not notched; caudal truncate; second anal spine about one third as long as the head, equal to third, and a little stouter; pectoral about one half as long as the head.

D. X, 13; A. III, 7; scales 6–48–15, pores 45 to 50; B. 6.

Coloration in spirits brownish; a dark area from front of anal up to soft dorsal; before this a whitish area; upper parts with faint, interrupted dark streaks along the rows of scales; a dark band upward from middle of base of ventrals; fins clouded. Length 10 inches. (After *Jordan & Evermann*)

De Kay described a specimen 4½ inches long as of a yellowish-gray color, with three or more dusky vertical bands, and with ventral fins tinged with blackish toward their tips. He regarded it as an accidental visitor from the tropics. The subject of his notes was an example seen several years prior to the publication of his work in the collection of Mr Hamilton, who informed him that it had been taken in the harbor of New York. There appears to be no later record of the occurrence of the species on our coast. De Kay refers to a specimen from Jamaica, but the range is generally restricted to the coasts of Brazil and Uruguay.

Genus **RYPTICUS** Cuvier

Body oblong, compressed, covered with very small, smooth, embedded scales. Lateral line normal; head scaly. Mouth rather large, oblique, the lower jaw the longer; maxillary with a supplemental bone, as in Epinephelus, with which genus this form agrees in general osteology; smooth area on top of cranium very large, transversely convex, much longer than the supraoccipital crest; interorbital area very narrow; parietal and supraoccipital bones short, with feeble crests which do not extend on the frontals; premaxillaries reaching frontals, which have a fossa in front; teeth all villiform, in

bands on jaws, vomer, and palatines; preopercle crescent shaped, without angle or serratures, but provided with two or three spinous hooks on the posterior margin; opercle with two or three spines; gill rakers short. Branchiostegals 7. Dorsal fins separate, the first of two or three (rarely four) small spines, the second of many (about 25) soft rays; anal long, rounded, of soft rays only; caudal rounded; pectorals rounded, nearly symmetrical, of 17 rays; ventrals small, I, 5, inserted slightly before pectorals, the spine short and strong. Vertebrae 10+14=24. Skeleton generally similar to that of Epinephelus.

Subgenus PROMICROPTERUS Gill

266 **Rypticus bistrispinus** (Mitchill)

Soapfish

Bodianus bistrispinus Mitchill, Am. Month. Mag. II, 247, February, 1818. Bahamas.

Rhypticus maculatus Holbrook, Ichth. S. C. ed. 1, 39, pl. 6, fig. 2, 1856; ed. 2, 42, 1860, *Cape* Romain S. C.; Günther, Cat. Fish. Brit. Mus. I, 173, 1859; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 543, 1883.

Rhypticus decoratus Jordan & Gilbert, op. cit. 543, 1883.

Rypticus bistrispinus Jordan & Eigenmann, Bull. U. S. F. C. VIII, 338, 1890; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1233, 1896, pl. CXCIV, fig. 509, 1900.

This species has a moderately deep body, its depth greater than the length of the head, specially in the adult in which the back is considerably elevated; profile of head much depressed before eye, the sharp snout abruptly projecting. The length of the head is one third of the standard body length; the depth of body is contained from two and one third to two and two thirds times in its length; the eye in adult nearly as long as snout, its length contained five and one half times in length of head; maxillary three sevenths as long as the head, reaching to below posterior margin of eye; preopercle with only two developed spines, the uppermost usually wholly wanting; the median spine often divided, the lower one largest and directed partly downward; opercular spine small; first dorsal spine a little lower than second, which is nearly or quite free from the soft rays; gill rakers short and thick, close set, eight to 10 in number. D. II, 25; A. 14 or 15.

Color. Dusky olive brown, somewhat clouded; sides with a few irregular whitish spots; young spotted with brownish.

South Atlantic coast, U. S., straying northward to coast of Rhode Island. The species is frequently taken in moderately deep water off Charleston, Pensacola and Key West. Mitchill described it from the Straits of Bahama. The common name is given in allusion to the soapy feeling of the skin. The fish is small and has no value for food. Nothing is recorded of its habits.

Family LOBOTIDAE

Triple-tails

Genus LOBOTES Cuvier

Body oblong, compressed, and elevated, covered with moderate-sized, weakly ctenoid scales; profile of head concave, the snout prominent; mouth moderate, oblique, with thick lips; upper jaw very protractile; lower jaw the longer; maxillary without supplemental bone; jaws with narrow bands of villiform teeth, in front of which is a row of larger conical teeth directed backward; no teeth on vomer or palatines; preorbital narrower than eye; preopercle strongly serrate. Branchiostegals six. Dorsal fin continuous, with 12 spines which may be depressed in a shallow groove; soft rays of dorsal and anal fins elevated; anal spines graduated; bases of soft dorsal and anal thickened and scaly; caudal rounded. Air bladder present. Pyloric caeca three.

267 Lobotes surinamensis (Bloch)

Flasher; Triple-tail

Holocentrus surinamensis Bloch, Ichthyol. pl. 243, 1790, Surinam.

Bodianus triurus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 418, pl. III, fig. 10, 1815, Powles Hook, N. J.

Lobotes auctorum Günther, Cat. Fish. Brit. Mus. I, 338, 1859.

Lobotes surinamensis Cuvier & Valenciennes, Hist. Nat. Poiss. V, 319, 1830; De Kay, N. Y. Fauna, Fishes, 88, pl. 18, fig. 49, 1842, New York; Holbrook, Ichth. S. C. ed. 1, 159, pl. 23, fig. 2, 1856; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 555, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1235, 1896, pl. CXCIV, fig. 510, 1900; H. M. Smith, Bull. U. S. F. C. 1897, 100, 1898; Sherwood & Edwards, Bull. U. S. F. C. 1901, 28, 1901, Narragansett Bay.

The body is oblong, deep, its depth four ninths of its length without the caudal; least depth of caudal peduncle three tenths

of body depth; profile of head very oblique; nuchal region convex; head short, its length less than one third of total without caudal; lower jaw prominent; maxillary very heavy, extending beyond middle of orbit, its width one half diameter of eye; snout about equal to eye which is one sixth as long as the head; scales around eye very small, those on opercle large; first dorsal spine shortest, two thirds as long as the second, two fifths as long as the third, one fourth as long as the fifth and longest, which is three eighths as long as the head; the longest ray of soft dorsal is one half as long as the head, and about equal to the longest ray of the anal; anal spines graduated, the first being two thirds as long as the eye and the third one fourth as long as the head; the pectoral reaches to below the seventh spine of the dorsal, its length one half the length of head; the ventral origin is under the lower axil of the pectoral; the ventral fin equals the postorbital part of the head in length, and reaches to below the tenth spine of the dorsal. Base of soft dorsal, anal, and caudal with fine scales. D. XI, I, 16; A. III, 11; V. I, 5; P. I, 15; scales 59 (pores about 53).

Blackish above, silvery gray on the sides, often blotched and tinged with yellow; fins dusky gray, sometimes mingled with yellow.

The flasher is a large species, found in all warm seas, ranging on our coast from Cape Cod to Panama; it reaches the length of 3 feet and is used for food. At Woods Hole, according to Dr Smith, it is very rarely taken. Specimens were secured, however, in August 1873, December 1875, Sep. 20, 1886, and in August 1890. The individual obtained in 1886 was caught in a trap at Menemsha, Martha's Vineyard. The Rhode Island Fish Commission has a specimen weighing 6 pounds and measuring 22 inches, which was taken Sep. 10, 1900, in a trap off Prudence island, Narragansett bay. The example described and figured by Mitchill was taken at Powles Hook N. J. According to Mitchill specimens weighing four or five pounds were occasionally secured, and the fish was sometimes called black grunt. De Kay knew the fish only from the accounts of it given by Mitchill and Holbrook.

Family PRIACANTHIDAE

Catalufas

Genus PRIACANTHUS Cuvier

Scales very small, 80 to 100 in the lateral line; body oblong, more than twice as long as deep; preopercle with a spine at angle; interorbital area externally transversely convex, the cranium itself transversely concave, the elevation being formed of flesh; a conspicuous foramen in the interorbital area; lateral line extending upward and backward from upper angle of gill opening toward second dorsal spine, below which it changes its course, following outline of back to end of dorsal fin, thence direct to middle of caudal; anal fin rather long, its rays about III, 14; dorsal rays about X, 13. Species rather numerous, in the tropical seas.

268 **Priacanthus arenatus** Cuv. & Val.

Catalufa; Bigeye

Priacanthus arenatus CUVIER & VALENCIENNES, Hist. Nat. Poiss. III, 101, 1829, Brazil; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 971, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1237, 1896. pl. CXCV, fig. 511, 1900; H. M. SMITH, Bull. U. S. F. C. 1897, 100, 1898. Woods Hole, Mass.

Priacanthus macrophthalmus CUVIER & VALENCIENNES, Hist. Nat. Poiss. III, 97, 1829, based upon *Anthias macrophthalmus* BLOCH, an Asiatic species; GÜNTHER, Cat. Fish. Brit. Mus. I, 215, 1859; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 544, 1883.

Body oblong, compressed, moderately long, its greatest depth about one third of the total length without caudal; the caudal peduncle slender, its least depth equal to length of snout. The head is rather short, about two sevenths of total without caudal; the snout is short, one fourth as long as the head, and two thirds as long as the eye; the interorbital space is narrow and convex; the posterior nostrils are in a common oblong opening within which is a septum considerably below the surface; gill rakers 20 to 23; the maxillary is broad posteriorly and reaches to below the front of the pupil; the lower jaw projects considerably; preopercle with an oblique point at its angle; opercle with a flat pointed spine, not projecting. Dorsal spines all slender, the first only one half as long as the last and two ninths as

long as the head; the anterior portion of the spinous dorsal is regularly graduated; no notch between the spines and soft rays and the soft rays are not longer than the spines; dorsal spines more or less granulate on the edges. Caudal slightly concave, its lobes subequal, the middle rays nearly one half as long as the head. Ventral origin slightly in advance of origin of spinous dorsal; the fin reaches to a point nearly under the eighth spine of the dorsal, but not to the anal origin. Pectorals about one half as long as the head. First anal spine two thirds as long as the third, and one fourth as long as the head; the longest anal ray is less than one half as long as the head. D. X, 14; A. III, 15; V. I, 5; P. I, 16; scales 9–98 to 115–42; pores wanting on some of the scales.

Color, silvery red; anal, soft dorsal, and caudal with a black edge; no spots on dorsal; posterior half of ventral black; about eight small dark blotches along lateral line, the largest less than one half as long as the pupil.

The catalufa is a native of the tropical parts of the Atlantic; it has been recorded from Brazil, the West Indies, and Madeira, and sometimes migrates northward in the Gulf Stream to Narragansett Bay, Vineyard sound, and neighboring waters in summer.

At Woods Hole it is rare; seven specimens were obtained in September and October 1876, and afterward for several years three or four were caught annually. On Oct. 2, 1888, a specimen $3\frac{3}{4}$ inches long was taken in a seine at Quisset Harbor.

Genus PSEUDOPRIACANTHUS Bleeker

Scales large, very rough, 35 to 50 in the lateral line; body ovate, not twice as long as deep; preopercle with two small spines at angle; interorbital space broad and flat, there being little flesh between skin and skull; no foramen in interorbital area; lateral line changing its course below the fourth dorsal spine; anal short, its rays III, 9 to 11; dorsal X, 11. Otherwise essentially as in Priacanthus, the species living in deeper water.

269 Pseudopriacanthus altus (Gill)

Short Bigeye

Priacanthus altus Gill, Proc. Ac. Nat. Sci. Phila. 132, 1862, Narragansett Bay; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 545, 1883.

Pseudopriacanthus altus Goode & Bean, Bull. Essex Inst. XI, 29, 1879; Jordan & Eigenmann, Proc. U. S. Nat. Mus. 269, 1887; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1239, 1896, pl. CXCV, fig. 512, 1900; H. M. Smith, Bull. U. S. F. C. 1897, 100, 1898; op. cit. 1901, 33, 1901, Woods Hole, Mass.

Body ovate, compressed, its greatest depth one half of the total length without caudal; the caudal peduncle short and stout, its least depth two thirds of its length and equal to postorbital part of head. Profile little oblique; mouth large, subvertical; snout short, one half as long as the eye, which is nearly one half as long as the head; maxillary very broad posteriorly, its width nearly one half its length, extending to beyond the middle of the pupil. Head large, nearly two fifths of total length without caudal; teeth in upper jaw in a narrow villiform band, the outer series enlarged; similar teeth in the lower jaw, but the inner teeth larger than in the upper jaw; preorbital strongly serrate, narrow, one half diameter of pupil; preopercle serrate, the serrae of the lower margin largest; no preopercular spine; opercle and subopercle serrate on their lower margins. Dorsal spines from the first to the fifth graduated, the first two fifths as long as the fifth, which is as long as the snout and eye combined; the last spine is one half as long as the head; the first soft ray is two thirds as long as the head, and the longest soft ray equals the length of the head without the snout, the last dorsal ray is about as long as the first dorsal spine. The caudal is slightly convex, its middle rays equal to snout and eye combined. Anal spines graduated, the first one third as long as the head, the third nearly one half as long as the head; the anterior soft rays are produced as in the dorsal, the longest as long as snout and eye combined. The short and broad pectorals are nearly one half as long as the head. Ventrals large, extending to the third spine of anal fin. Scales all extremely rough, very strongly ctenoid, smallest on the head, but larger on the

maxilla than elsewhere on the head; lateral line ascending over the pectoral, then nearly following the outline of the back to the caudal peduncle, where it becomes median.

D. X, 11; A. III, 9; scales 10–45–23.

Color in life bright red or crimson; the fins, except the pectorals, with black tips; the eye glowing like molten gold.

The species is found in rather deep water in the West Indies and from the Caribbean to Charleston, the young often following the Gulf Stream northward in summer to Cape Cod. The largest individual recorded is 11 inches long. Most of the specimens taken near Cape Cod are small. The northern limit of the fish appears to be Marblehead Mass., where an example was taken Sep. 3, 1859.

The type of the species was collected in Narragansett bay. Individuals were obtained at Woods Hole Mass., Sep. 29, 1875, Sep. 26, 1877 and Nov. 28, 1885. On Nov. 1, 1890, a specimen was found in the Acushnet river, at New Bedford. In 1899 over 100 specimens were taken at Woods Hole, and in 1900 only nine were observed between August 15 and September 8. The writer obtained the species in moderate numbers in the Gulf of Mexico in 1886. The colors of large individuals appear to be less brilliant than in the young, but the fish is always strikingly handsome.

Family LUTIANIDAE

Snappers

Genus NEOMAENIS Girard

Body oblong, compressed, the back somewhat elevated; head long, naked above, except for a broad oblique band of scales at the nape; nostrils normally close together, neither with a tube; mouth large, the jaws with bands of villiform teeth, besides which there is usually an outer series of larger teeth in each jaw, and two to four stronger teeth or canines in front of upper jaw; vomer with villiform teeth; villiform teeth on the palatines; usually one or more patches of teeth on the tongue in the adult; no molar teeth; no teeth on pterygoids; preopercle without notch or with a shallow emargination; posterior limb

of preopercle finely serrate; gill rakers rather few, shortish; soft rays of dorsal and anal scaly at base; dorsal spines 10 (rarely 11), continuous with the soft rays; caudal lunate or forked; anal rays seven to nine. Interorbital area not flat nor separated from the occipital region, the median and lateral crests procurrent on it, and the frontal narrowed forward; fronto-occipital crest ceasing anteriorly far from front of frontal, usually behind eye; prefrontal with posterior areas impressed, long and cribriform; parietal crest not confluent with orbital rim, but nearly or quite joined anteriorly to fronto-occipital crest (in species examined); prefrontals with the articular facets arising from diverging V-shaped ridges; basisphenoid with an anterior lobiform extension. Vertebrae 10+14=24.

270 Neomaenis griseus (Linnaeus)

Gray Snapper; Mangrove Snapper

Labrus griseus Linnaeus, Syst. Nat. ed. X, I, 283, 1758.

Mesoprion griseus Cuvier & Valenciennes, Hist. Nat. Poiss. II, 469, 1828, San Domingo.

Lobotes emarginatus Baird & Girard, 9th Smithson. Rep. 332, 1855, Beesley's Point, N. J.

Mesoprion caballerote Poey, Repertorio, II, 157, 1868.

Lutjanus caballerote Poey, Syn. Pisc. Cubens. 293, 1868; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 921, 1883; Goode & Bean, Proc. U. S. Nat. Mus. VI, 42, 1884.

Lutjanus stearnsii Goode & Bean, Proc. U. S. Nat. Mus. I, 179, 1878, Pensacola Fla.; Goode, Fish & Fish. Ind. U. S. I, 396, pl. 142, 1884.

Lutjanus griseus Jordan & Swain, Proc. U. S. Nat. Mus. 439, 1884; Jordan & Fesler, Rept. U. S. F. C. 1889 to 1891, 441, 1893.

Neomaenis griseus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1255, 1898; H. M. Smith, Bull. U. S. F. C. 1897, 100, 1898; op. cit. 1901, 33, 1901.

Body elongate, its depth about one third of total length without caudal; back not much compressed; profile from snout to nape almost straight; outline of back slightly convex. Head rather large, four elevenths of total length without caudal; the snout pointed, one third as long as the head; eye small, two thirds as long as the snout, rather more than one fifth as long as the head; preorbital broad, about as broad as the interorbital space which is gently convex and one sixth of length of head; occipital keel low. Mouth large, the jaws nearly equal in front;

the maxillary reaches to below front of pupil, its length contained two and three fifths times in length of head; eight developed gill rakers on the first arch, one above and seven below the angle, the longest one half as long as the eye; there are seven rows of scales on the cheeks; the single patch of lingual teeth twice as long as broad; vomerines in a triangular patch on the head, with a long, narrow backward extension; palatines in a broad band; scales extend upon the membranes of the dorsal, anal and caudal fins for about one half their hight, or rather more on the caudal; two very strong canines in the upper jaw, and two much smaller ones between these and the symphysis; mandible without enlarged canines; preopercle finely serrate above, coarsely serrate at angle, the posterior margin nearly vertical, with a broad and deep notch; scales comparatively large, in horizontal rows below the lateral line, those above lateral line running parallel with it till below the soft dorsal, where they become slightly irregular and oblique; seven rows of scales on cheek; an embedded row on interopercle; a row on subopercle, and seven rows on opercle; temporal region with about three rows of large scales; top of head, snout, and jaws naked.

The first dorsal spine is one eighth as long as the head, one half as long as the second and the last; the fourth and longest spine is one third as long as the head; the longest ray of the soft dorsal is equal to the longest spine; the last ray is one half as long as the upper jaw. The caudal is slightly emarginate, the upper lobe slightly the longer, the middle rays five ninths as long as the head. The first anal spine is three sevenths as long as the third which is nearly as long, but not so strong, as the second and nearly one fourth as long as the head; the second anal ray is longest, nearly four ninths as long as the head, and more than one seventh of total length without caudal. Ventrals one fifth of total length without caudal; pectorals one fourth of the same length, and scarcely reaching vent. B. VII; D. X, 14; A. III, 8; V. I, 5; P. I, 16; scales 7–47 to 50–12 to 14; 47 pores in lateral line.

The edge of the spinous dorsal membrane is black. The caudal has a narrow black margin. The included portion of the maxilla is brown. The scales of the body below the lateral line have median golden stripes, as in some species of Mugil.

Color in life, very dark green above, the middle part of each scale brassy black, its edge broadly pearly whitish; below lateral line the duskiness of the middle of the scale passes into brassy, and below into bright coppery, the belly and lower parts of head being more or less distinctly bright coppery red; the lower jaw grayish; no blue stripe below eye except in the very young; top of head blackish olive; dorsal blackish, its margin darker and tinged with maroon red; soft dorsal dusky, anteriorly slightly edged with whitish; caudal violaceous or maroon black; anal wine color, edged with whitish; pectorals pale flesh color; ventrals whitish, faintly marked with reddish. Young with a blackish band from snout through eye to nape; a blue streak below eye; spinous dorsal with a maroon colored band along edge.

The gray snapper inhabits the West Indies, the Caribbean sea and southward to Brazil, the Gulf of Mexico, and our Atlantic coast northward regularly to New Jersey, and, frequently, to Cape Cod. The fish is valuable as food; it probably reaches a length of nearly 3 feet and the weight of 20 pounds. Only young examples have been identified with certainty from the Cape Cod region. On Sep. 21, 1897, a specimen, 2½ inches long, was taken in Eel pond, at Woods Hole Mass., and on Sep. 26, 1897, an individual 2 inches long was caught in Great Harbor, Woods Hole. This is the first record of its occurrence in the locality. On Aug. 29, 1900, five specimens, the largest 1⅝ inches long, were taken in Katama bay, near Woods Hole, according to Dr Smith. In these "the general color is pale, with 6 to 8 narrow, dark, longitudinal stripes; spinous dorsal fin dark, with a sharply defined blackish bar involving the distal part of the fin, the extreme edge being white."

271 Neomaenis blackfordi (Goode & Bean)

Red Snapper

Lutjanus blackfordii Goode & Bean, Proc. U. S. Nat. Mus. I, 176, 1878 (full description of adult); II, 137, 138, 1879, characters and measurements of young; Goode, Game Fishes N. A., 16, 1878, with colored plate.

Lutjanus blackfordi JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 549, 1883; BEAN, 19th Rep. Comm. Fish. N. Y. 263, pl. XVI, fig. 20, 1890.

Lutjanus campeachianus JORDAN & GILBERT, op. cit. 971 (not *Mesoprion campeachanus* POEY, Mém. Cub. II, 149, 1860); JORDAN, Proc. U. S. Nat. Mus. VII, 35, 1884.

Neomaenis aya JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1264, 1898, pl. CXCVII, fig. 516, 1900 (not *Bodianus aya* BLOCH, Ichthyol. 227, 1790); H. M. SMITH, Bull. U. S. F. C. 1897, 100, 1898.

Neomaenis blackfordi H. M. SMITH, Bull. U. S. F. C. 1901, 33, 1901.

Body much compressed; its upper profile ascending from the snout, with a slight concavity in front of eye, to the origin of the spinous dorsal, thence descending in a long curve to the base of the caudal; under profile much less arched. Jaws equal. Greatest hight of body equals length of head, which is three eighths of total length without caudal. Least depth of caudal peduncle equals one third of the distance from the snout to the pectoral. Preoperculum finely and evenly serrated, except at the angle, where the denticulations are coarser; a slight emargination above the angle, in which is received an elevation upon the interopercle, and two shallower emarginations above. Maxillary not reaching to below front of orbit; mandible not below middle of orbit. Lingual teeth in two patches. Vomerine patch a quadrilateral figure, with concave sides, and with the longest sides posteriorly. Palatine patches somewhat spatulate, broadest posteriorly. Eye circular, its diameter contained seven and one third times in length of head. Snout nearly equal to maxillary. Mandible equal to one half hight of body at ventrals. Distance of spinous dorsal from snout about three times length of snout; length of its base about equal to pectoral. Longest dorsal spine three times as long as the first, and twice as long as the second anal spine; it is nearly as long as the snout. The longest dorsal ray (sixth) is contained three and one fourth times in the length of the head. The anal base is a little longer than the mandible; the first anal spine is one half as long as the second, which is one third as long as the ventral fin; the third spine is slenderer and slightly longer than the second; the longest ray of the anal is twice as long as the snout. Caudal much emarginate, crescent-shaped; the middle

rays two thirds as long as the outer. Pectoral midway between snout and origin of anal, its length twice that of the maxillary. Ventral as long as snout and eye combined, slightly more than one half as long as head; it extends to below the eighth spine of the dorsal. B. VII; D. X, 14; A. III, 9; V. I, 5; P. I, 16; scales 8 to 9–50–15 to 16; gill rakers on lower arch, 8.

The scales extend half the length of the anal rays on the membrane; on the external caudal rays they extend nearly to the tip, and with slight traces upon the spinous dorsal in front of the spines; and in the soft dorsal somewhat more extended.

Color uniform scarlet. Center of scales lighter, also the belly, which is silvery; inside of axil of pectoral darker maroon.

On Oct. 26, 1887, Mr E. G. Blackford, Fish Commissioner of the State of New York, forwarded to the National Museum a young red snapper, four and one half inches long, which was caught in Great South bay, at Bay Shore, Long Island. This is the smallest red snapper that we have obtained, and it is the first record of the occurrence of the species so far north. The specimen has been catalogued as 39213 of the *Museum Fish Register*.

As in other young fishes the size of the eye, the length of the head and the colors are different from these characters in the adult.

A description of the colors of the fresh fish follows:

A dark band nearly as wide as the diameter of the eye is placed immediately in front of the spinous dorsal; it fades out about the median line of the body. Three similar bands, and of like size, under the dorsal, separated by narrow interspaces and fading out below. The fourth band contains a blotch as large as the eye, which passes slightly beneath the lateral line. A fifth band is under the last third of the soft dorsal and continues backward to the caudal, not descending below the lateral line. The second and third bands are traversed vertically by a narrow median stripe of the rosy body color. Membrane of dorsals and caudal with a narrow black edge. Spine and external ray of ventral milk white. Anal rosy, except membrane of first two spines and last three rays, which is milk white.

On July 12, 1890, Mr Vinal N. Edwards obtained a specimen of the red snapper, which weighed 12 pounds, from a bass trap set in 10 feet of water, at Menemsha, Martha's Vineyard. Mr Edwards believed this to be the first one taken on the Massachusetts coast, but thought one was caught some years ago near Block Island.

On October 10, 1890, a specimen weighing 8½ pounds was taken at the same place. On September 7 and 11, and October 20, 1900, nine specimens were taken in the vicinity of Woods Hole Mass. and recorded in the article of Dr Smith. The largest of these was under 2 inches long. Dr Smith described the colors as follows: "General color, red like the adult fish; body marked by about seven double dark cross-bands; in the cross-band nearest the junction of the two parts of the dorsal fin is a large jet black blotch extending from the fin to below the lateral line; spinous dorsal dusky; soft dorsal with a dusky median zone and a dark edge; caudal pale, with a dark narrow border."

The red snapper has become one of the most famous fishes of our northern markets, and is always attractive on account of its large size, brilliant color, and the excellence of its flesh. We know that the species is to be found on our east coast from Cape Cod to the Carribbean sea. It is rare, however, north of Cape Hatteras and the principal fisheries are located off the coasts of Georgia and Florida, and in the Gulf of Mexico.

When the red snapper was named in honor of Mr Eugene G. Blackford, in recognition of his invaluable contributions to the science of ichthyology, the describers of the species had carefully considered the question of nomenclature and satisfied themselves that none of the names known to them could with certainty be associated with this fish. Various earlier names have been suggested from time to time by several authors as possibly available for the species. In 1883 Dr D. S. Jordan considered it to be the L. c a m p e c h i a n u s, described by Poey in 1860. This, however, is a species with much smaller scales if the description be accurate. The type has not been examined by any one in the United States so far as I am informed.

A little later Dr Jordan suggested that the name Lutjanus vivanus of Cuv. & Val. should be accepted for the red snapper; but my examination of the types of this species in the Museum at Paris showed it to be a small Lutjanus, and very distinct in every way from L. blackfordi. In recent lists Dr Jordan has adopted the specific name aya of Bloch, published in 1787 in the *Ausländische Fische*. This name was used for a species of Lutjanus more than twenty years ago by Dr Theodore Gill.

I will now state what may be learned from the literature concerning the aya. The Bodianus aya of Bloch is distinctly based upon the Acara aya of Maurice, prince of Nassau, as set forth in his mss, tome 2, page 351. The plate published by Bloch is copied from a drawing by Prince Maurice, and his description is drawn from the same source. The fish which formed the subject of the description and illustration by the prince of Nassau was the aya or Garanha of Brazil, a red species, said to attain to a length of 3 feet. The aya is distinctly described as having 9 spines and 18 articulated rays in the dorsal. It is represented as having 40 scales in the lateral line, and the scales are said to be ornamented with silvery, submarginal stripes. Bloch was informed that the fish was known to the French, Germans and English as the aya and to the Brazilians as the garanha. Elsewhere in the description the general color is said to be red, the back dark red, and the belly silvery. This is all the information to be derived from Bloch's account of the species, and if the data mentioned are to be relied upon, the fish is certainly not our red snapper. We have no other knowledge concerning the aya of Brazil. It has not been shown that our species ranges so far south and several red forms resembling L. blackfordi are associated with it. Various interpretations of the aya have appeared in ichthyological works. Dr Günther, in his *Catalogue of Fishes in the British Museum*, vol. I, page 198, adopts the name for a small-scaled Lutjanus, which has 65 scales in the lateral line and 32 in a transverse series. Of this he has a fine

specimen from South America. A very curious translation of the earlier descriptions of the a y a is to be found in Lacépède's account of the species, which is given below. The diagnostic characters are stated as follows:

Nine spines and 18 articulated rays in the dorsal; one spine and eight divided rays in the anal; the caudal crescent-shaped; each opercle terminating in a long and flat spine; the general color red; the back blood color; the belly silvery.

The author, in another part of his *Natural History of Fishes*, writes:

A figure of the aya has been published by Marcgrave, Piso, Willughby, Jonston, Ruysch, the prince of Nassau [Maurice] and Bloch, who has copied the drawing of Prince Maurice. It is found in lakes of Brazil. It frequently reaches a length of one meter, and it is so plentiful that large numbers of this species are salted or sun-dried for export. It may be very desirable and, perhaps, sufficiently easy to acclimatize this large and beautiful *bodianus*, the flesh of which is very agreeable to the taste, in the fresh waters of Europe, and particularly in lakes and ponds of France.

Family HAEMULIDAE

Grunters

Genus ORTHOPRISTIS Girard

Body moderately elongate, compressed, the back arched; head compressed, the snout usually long; mouth rather small, placed low; teeth in jaws in villiform bands, the outer teeth above somewhat enlarged; eye moderate; preopercle with its vertical limb straight, finely serrate or entire; gill rakers rather long and slender; dorsal spines rather slender, 12 or 13 in number, the fin usually not much notched; soft dorsal long and low, usually with 15 or 16 rays, the membranes usually naked; anal spines small; caudal lunate. Scales rather small, those above lateral line arranged in series not parallel with it; usually no smaller accessory scales at base of the larger ones. This genus contains a considerable number of species differing from Pomadasis in the long anal fin, the smaller scales, and in the less development of the dorsal spines. Nearly all the species are American.

272 Orthopristis chrysopterus (Linnaeus)

Pigfish; Hogfish

Perca chrysoptera Linnaeus, Syst. Nat. ed. XII, 485, 1766, Charleston, S. C.

Labrus fulvomaculatus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 406, 1815, New York.

Pristipoma fasciatum Cuvier & Valenciennes, Hist. Nat. Poiss. V, 285, 1830, New York, young; Gunther, Cat. Fish. Brit. Mus. I. 301, 1859, New Orleans.

Haemulon fulvomaculatum De Kay, N. Y. Fauna, Fishes, 84, pl. 7, fig. 21, 1842, New York; Holbrook, Ichth. S. C. 156, pl. 22, fig. 2, 1856.

Pristipoma fulvomaculatum Gunther, Cat. Fish. Brit. Mus. I, 301, 1859, copied from Holbrook.

Orthopristis duplex Girard, U. S. Mex. Bd. Surv. Zool. Fish. 15, pl. 9, figs. 1 to 4, 1859, Texas.

Pomadasys fulvomaculatus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 551, 1883.

Orthopristis chrysopterus Bean, Bull. U. S. F. C. VII, 142, pl. III, fig. 11, 1888; Jordan & Fesler, Rept. U. S. F. C. 499, 1893; Bean, Bull. Am. Mus. Nat. Hist. IX, 366, 1897; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1338, 1898, pl. CCX, fig. 541, 1900.

Body oblong, compressed, not much elevated. The depth of the body is one third of the length, which is three and one third times the length of the head; head long; snout conic; mouth low and small, the maxillary barely reaching to the nostrils; outer teeth slender and rather short; eye placed high, $4\frac{1}{2}$ in head, nearly midway in its length, its diameter two thirds depth of the broad preorbital; dorsal and anal entirely naked, with a sheath of scales at base; anterior spines of dorsal higher than the posterior, which are lower than the soft rays; anal spines short, graduated; pectoral moderate, reaching past tips of ventrals; caudal forked, the upper lobe the longer. Length 1 foot to 15 inches.

D. XII, 16; A. III, 12; Lat. 1, 75; pyloric caeca six.

Light brown, silvery below; sides with numerous orange colored and yellow spots; those above the lateral line in oblique series, those below in horizontal; vertical fins with similar spots; head bluish with yellow spots; angle of mouth and gill membranes with orange.

The pigfish ranges along the Atlantic coast from New York southward; adult individuals are rarely seen even as far north as New Jersey, but the young are common.

At Beesley's Point N. J. Aug. 10, 1887, many young individuals were taken in the seine. D. XII, 16; A. III, 13; scales, 75.

A dark stripe beginning on nape and dividing sends one branch along the back on each side not far from dorsal outline; a dark stripe from eye to root of caudal; cheeks and opercles with several narrow orange stripes; a narrow orange stripe between the two dark body stripes and another below the lower dark stripe; below the second orange stripe with numerous orange spots, not continuous. These specimens are from less than 1 inch to more than 2 inches long.

Young examples were seined at Somers Point, August 13, and abundantly at Ocean City, August 16. The croaking sound made by these little fishes is quite noticeable.

September 5, Mr W. S. Keates brought in two examples which had been caught on a hook with clam bait; these are 5¼ inches long, and much larger than the average size. Specimens from 4½ to 5 inches long were caught at Beesley's Point, August 23; in these there is only a trace of the black lateral stripe along the median line, and the sides have several broad, dark bands.

September 9 an individual 5⅓ inches long was taken at Beesley's Point. This species is unknown to the fishermen. One angler described its croaking as resembling the quacking of a duck.

Several examples were taken in Gravesend bay, Oct. 24, 1894. De Kay mentions it as a rare fish, but occasionally appearing, he was informed, in New York harbor in considerable numbers. He states that it is a very savory food.

Family SPARIDAE

Porgies

Genus STENOTOMUS Gill

This genus is close to C a l a m u s, having the same quill like interhaemal bones, the flattened incisors and antrorse dorsal spine mainly distinguishing it; temporal crest obsolete; frontal bones not gibbous nor porous; antrorse spine attached to the fourth interneural by a downward projecting spine about thrice as long as the spine; lateral crest nowhere coalescing with the

supraoccipital crest; interorbital area flattish, with two low ridges, a small foramen in each of these above front of pupil; interorbital area much contracted anteriorly; a strongly projecting prefrontal process, which makes an acute angle with the supraorbital. American shore fishes.

273 Stenotomus chrysops (Linnaeus)

Scup; Porgy; Sand Porgee

Sparus chrysops Linnaeus, Syst. Nat. ed. XII, 471, 1766, Charleston S. C.

Sparus argyrops Linnaeus, Syst. Nat. ed. XII, 471, 1766, Charleston S. C. young.

Labrus versicolor Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 404, pl. III, fig. 7, 1815, New York.

Sargus arenosus De Kay, N. Y. Fauna, Fishes, 91, pl. 22, fig. 67, 1842, Long Island, young.

Pagrus argyrops De Kay, op. cit. 95, pl. IX, fig. 25, 1842; adult; Günther, Cat. Fish. Brit. Mus. I, 472, 1859.

Sargus ambassis Günther, Cat. Fish. Brit. Mus. I, 449, 1859, New York.

Diplodus argyrops Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 557, 1883.

Stenotomus argyrops Goode & Bean, Bull. Essex Inst. XI, 17, 1879, Cape Ann Mass.

Stenotomus chrysops Bean, Bull. U. S. F. C. VII, 142, 1888; 19th Rep. Comm. Fish. N. Y. 261, pl. XIV, fig. 18, 1890; Jordan & Fesler, Rept. U. S. F. C. 1889 to 1891, 507, 1893; Bean, Bull. Am. Mus. Nat. Hist. IX, 366, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 100, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1346, 1898, pl. CCXI, fig. 544, 1900; Bean, 52d Ann. Rept. N. Y. State Mus. 106, 1900; Sherwood & Edwards, Bull. U. S. F. C. 1901, 28, 1901.

Body ovate-elliptic, compressed, its greatest depth nearly one half of total length without caudal; anterior profile steep, nape convex, a strong depression above and in front of eye; least depth of caudal peduncle one fourth of greatest depth, and equal to postorbital part of head. Head short and deep, its length contained three and one fourth to three and one half times in total without caudal; snout one third as long as head; eye one fourth to one fifth as long as head, much narrower than the preorbital; mouth small, terminal, the maxillary reaching to below the posterior nostrils; incisor teeth very narrow, almost conical; molars in two rows above; cheeks short and deep, with four rows of scales; top of head, snout, orbitals, and chin naked; gill rakers small, about 6 + 10 on first arch; temporal crest obsolete; supraoccipital crest continuous with the frontal bones; a procumbent

spine in front of the dorsal; first dorsal spine as long as the eye; third, and longest, dorsal spine as long as the head without the snout; last dorsal spine nearly one third as long as head; soft dorsal highest in the middle, its longest ray (sixth) equal to snout. Caudal deeply forked, its middle rays two fifths as long as the external, and equal to snout. First anal spine three fourths as long as the eye; second and third about equal, two sevenths as long as the head; soft rays rather short, the first and second about as long as the snout. Pectoral long, reaching to above the second ray of the anal. Ventral four fifths as long as the head, reaching nearly to vent. D. XII, 12; A. III, 11; V. I, 5; P. I, 15. Scales 8–50–16.

Color silvery, with bright reflections, dusky above, upper part of head deep brown; dorsal horn color, the last rays with a yellowish tinge; axil of pectoral dusky; young with five or six dusky bars; iris golden, mottled with silvery and brownish. Length, about 1 foot.

The scup is one of our best known fishes. In many places it is better known under the name porgee. Mitchill and De Kay described it as the big porgee. Another spelling for the same name is pogy. Scup is an abbreviation of scuppaug, which in turn is a shorter form for the Narragansett name, mishcuppauog. The name fairmaid, which is said to be given to the scup on the Virginia coast, does not rightfully belong to this species, but rather to the sailor's choice (L a g o d o n). The name fairmaid is regularly applied to the latter species at Cape Charles Va. according to B. A. Bean. In Norfolk Va. Mr Bean heard the name maiden for the young of the common scup.

The scup seldom migrates north of Cape Cod, though it has been taken occasionally off Cape Ann. Attempts to introduce it into Massachusetts bay have been unsuccessful.

The scup comes into our northern waters in great schools, the large spawning fish coming first, making their appearance in New York waters in May. The species feeds upon small crustaceans, mollusks and annelids, and is one of the readiest biters along the coast. The fishery fluctuates greatly; in certain years

the fish is comparatively scarce, and in others it is extremely abundant. It is caught in pounds and traps, and remains in Great South bay till cold weather sets in. It has been taken on Cape Cod as late as December 10. Sometimes a sudden cold spell kills the fish in large numbers.

In 1890 we found only a few specimens at Fire Island and at East Island, late in September, and on October 1 a few examples were taken in a trap at Islip. In 1898, adults were taken in moderate numbers off Southampton, August 3. Half grown specimens were obtained at Islip, August 18. A single young individual was seined at Nichols's Point, September 1, and a moderate number of young, about 2 inches long, were secured at the east side of Fire Island inlet, September 16. In 1901 small scup, about 6 inches long, were obtained in a gill net, August 13, and in Watts's pound, July 31, in Clam Pond cove.

The scup arrives in Gravesend bay in May, and is taken as late as November. In captivity it lives till December, and in properly heated water it can be kept indefinitely. It is thrifty, and is seldom in bad condition.

At Woods Hole Mass. according to Dr Smith, the fish appears about May 1 and leaves about October 15 or 20, being most abundant in June and July. Spawning occurs during first part of June, and young $\frac{1}{2}$ inch to $\frac{3}{4}$ inch long are observed by the middle of July. The eggs are $\frac{1}{25}$ inch in diameter and hatch in four days at a mean temperature of 62° F. In 1900, the scup arrived off Newport April 21, at Cutty Hunk April 26, and at Woods Hole May 1. Hundreds of young are killed there annually by a sudden fall of temperature. The growth of the young is recorded by Sherwood and Edwards as follows: July 3, length $\frac{1}{2}$ to $1\frac{1}{2}$ inches; August 2, $1\frac{1}{2}$ to 2 inches; September 6, 2 to 3 inches; September 29, 3 to 4 inches; November 1, 4 inches. The largest individual observed weighed 3 pounds.

The young are devoured in large numbers by cod, weakfish, bluefish and other predaceous species.

Genus LAGODON Holbrook

The essential character of this genus is in the form of the skull. Supraoccipital and temporal crests nowhere coalescent, the interorbital area not swollen; frontal bone in the interorbital area thin, concave in transverse section; temporal crest low, separated from supraoccipital crest by a flattish area which extends forward on each side of supraoccipital crest and to groove of premaxillary spines. Otherwise essentially as in Archosargus, the antrorse dorsal spine present, the second interhaemal not modified. One species, the incisors deeply notched.

274 Lagodon rhomboides (Linnaeus)

Sailor's Choice

Sparus rhomboides LINNAEUS, Syst. Nat. ed. XII, 470, 1766, Charleston S. C.
Sargus rhomboides CUVIER & VALENCIENNES, Hist. Nat. Poiss. VI, 68, pl. 143, 1830; DE KAY, N. Y. Fauna, Fishes, 93, pl. 71, fig. 228, 1842, copied from CUVIER & VALENCIENNES; GÜNTHER, Cat. Fish. Brit. Mus. I, 447, 1859.
Diplodus rhomboides JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 558, 1883.
Lagodon rhomboides HOLBROOK, Ichth. S. C. ed. 1, 56, pl. 8, fig 1, 1856; ed. 2, 59, 1860; BEAN, Bull. U. S. F. C. VII, 142, 1888; 19th Rep. Comm. Fish. N. Y. 263, 1890; Bull. Am. Mus. Nat. Hist. IX, 366, 1897; H. M. SMITH, Bull. U. S. F. C. 1897, 101, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1358, 1898, pl. CCXV, fig. 552, 1900.

Body ovate, elliptic, compressed, and somewhat elevated, the axis of the body near the middle of its depth; snout about in the axis. The depth of the body is contained two and one third times in its length. Head rather sharp, the length contained three and one half times in that of the body. Mouth small, the upper jaw more freely protractile than usual. Molars in two series; anterior incisors each deeply notched. Cheeks with 5 or 6 rows of scales; scales on the breast little reduced in size. A procumbent spine before the dorsal fin; dorsal spines high, much higher than soft rays, the fourth highest; second anal spine little larger or longer than the third. Pectorals as long as the head; ventrals two thirds as long, not reaching to vent. D. XII, 11; A. III, 11. Scales 8–66–18.

Brownish, white below; sides of head and body with horizontal stripes of light blue and golden; six or seven very faint

darker vertical bands, disappearing with age; vertical fins yellowish, with bluish stripes; a dark axillary spot.

This is called the salt water bream by Schoepff and the rhomboidal porgee by DeKay. In Chesapeake bay it is the fairmaid. It is also called pinfish, squirrel fish, porgee, yellowtail and shiner. In Great South bay the name of the fish was unknown to the fishermen, and this is true in Great Egg Harbor bay, where the young are not uncommon in summer.

In Gravesend bay it is not a common fish, but is found occasionally in summer.

A single individual was obtained at Fire Island, October 1. The sailor's choice occurs as far north as Cape Cod, but it is not present in sufficient numbers to be considered among the important food fishes; south of Cape Hatteras, where it is abundant, it is valuable for food, and in many places is considered superior to sheepshead; this is specially so in the St John's river.

The sailor's choice feeds upon small invertebrates and minnows. It is caught with the hook and in cast nets and seines.

The eggs are described as pale blue in color and as large as mustard seed. Spawning takes place in the Gulf of Mexico in winter or early spring. The colors of the fish are very beautiful, the sides being ornamented with golden stripes on a pearly white ground and having numerous dark vertical bands.

Genus ARCHOSARGUS Gill

Body robust, short and deep, compressed, covered with large scales. Head deep, mouth moderate, the jaws with broad incisors in front and coarse molars on the sides; incisors entire or with a shallow notch; posterior nostril slitlike; opercles entire. Dorsal and anal spines strong, the soft parts of the fin short and rounded; a procumbent spine before the dorsal; caudal forked. Gill rakers small. Supraoccipital and temporal crests coalescent anteriorly, both disappearing in the gibbous interorbital area; frontal bone between eyes transversely convex and more or less honeycombed; temporal crest separated from occipital crest by an excavated area, bounded anteriorly by the lateral crest, which merges into the supraoccipital above eye.

This genus, like Lagodon, Stenotomus and Otrynter, which show the same character of the procumbent dorsal spine, is confined to American waters. There are two color types in the genus, one group being made up of the species with broad black crossbands, the other of species with golden streaks and inconspicuous crossbands, resembling the species of Lagodon.

Subgenus ARCHOSARGUS

275 Archosargus probatocephalus (Walbaum)

Sheepshead

Sparus probatocephalus Walbaum, Art. Gen. Pisc. 295, 1792, New York.

Sparus ovis Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 392, pl. 2, fig. 5, 1815, New York.

Sargus ovis Cuvier & Valenciennes, Hist. Nat. Poiss. VI, 53, 1830; De Kay, N. Y. Fauna, Fishes, 89, pl. 8, fig. 23, 1842; Holbrook, Ichth. S. C. ed. 1, 51, pl. 8, fig. 2, 1856; Günther, Cat. Fish. Brit. Mus. I, 447, 1859.

Diplodus probatocephalus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 558, 1883.

Archosargus probatocephalus Gill, Cat. Fish. East Coast N. A. 27, 1873; Bean, Bull. U. S. F. C. VII, 142, pl. III, fig. 10, 1888, Somers Point N. J., young; 19th Rep. Comm. Fish. N. Y. 262, pl. XV, fig. 19, 1890; Bull. Am. Mus. Nat. Hist. IX, 366, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 101, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1361, 1898, pl. CCXVI, fig. 554, 1900.

Body robust, becoming deep with age, the back compressed and elevated, the greatest depth from two fifths to one half of total length without caudal; the least depth of caudal peduncle equal to eighth dorsal spine, and three eighths length of head. Head one third or nearly one third of total length without caudal; eye placed high, one fifth to one fourth length of head; interorbital space one third greater than diameter of eye; mouth low, horizontal; maxillary reaching nearly to below front of pupil, slightly more than one third as long as the head; incisors entire or slightly notched, serrate in the young, their breadth about one half their length; molars in three series above, in two below; those of the inner series larger; those behind the incisors very small. Gill rakers about 3+6. Cheeks with six rows of scales; scales on breast very small, crowded. Occipital crest broad. Dorsal spines very

strong, the last considerably shortened so that the outline of the fin is emarginate, the fifth spine longest, four sevenths as long as the head, the first spine shorter than the eye; the third and fourth soft rays longest, two fifths as long as the head. The second anal spine more than twice as long as the first, very strong, two fifths as long as the head, and as long as the longest soft ray. Pectoral very long, longer than the head, and reaching nearly to or, sometimes, beyond the anal origin. Ventral large, one fifth of total length without caudal, reaching to below 19th spine of the dorsal.

D. XII, 10 to 12; A. III, 10 to 11; V. I, 5; P. I, 14. Scales 7 to 8–45 to 48–15 to 16.

Grayish, with about eight vertical black bands, which are about as broad as the interspaces; dorsal dusky; ventral and anal black; base of pectoral dusky; the dark bands are most distinct in the young.

The sheepshead ranges along the coast from Cape Cod to Texas; it is very rare as far north as Woods Hole Mass., but in southern waters it is still abundant. The species reaches a length of 30 inches and the weight of 20 pounds; it is one of the most valuable of our food fishes and is highly prized for its game qualities.

In August 1887, the sheepshead was known to have bred in Great Egg Harbor bay, N. J., where about 20 young individuals measuring from 1 inch to 1¼ inches were seined between August 10 and September 9. Adults at that time were present in the bay, but they were scarce. The bottom was covered with algae and convenient hiding places were found under the sod banks.

The fish is very unusual in Gravesend bay, Long Island. A large individual, weighing 13 pounds, was caught September 16, 1897, at Coney Island. That example proved hardy in captivity and the sheepshead generally can be easily kept if the water temperature be properly maintained.

The sheepshead was at one time common in Great South bay. For this statement we have the authority of Mr Erastus Gordon, of Patchogue, and the following account from Dr Mitchill's

Fishes of New York will substantiate the fact: "The sheepshead swims in shoals and is sometimes surrounded in great numbers by the seine. Several hundreds have often been taken at a single haul with the long sweeping-nets in use at Raynortown, Babylon and Fire Island. They even tell of a thousand brought to land at a draught. . . This fish is sometimes speared by torchlight in the wide and shallow bays of Queens county and Suffolk. His term of continuance is only during the warmest season; that is, from the beginning of June to the middle of September. . . . I have, however, known him to stay later; for one of the most numerous collections of sheepshead I ever saw in the New York market was on October 4, 1814; I have seen them as late as the 17th."

Scott, in 1875, referred to Fire Island as a good locality for sheepshead fishing, and also mentions superior feeding places in the South bay and about the wreck of the *Black Warrior*, near the Narrows.

We did not obtain the sheepshead in Great South bay, and believe it occurs there very rarely at the present time, though fishermen still seek them in a few localities and, I am informed, occasionally catch one. Dr Smith says not one has been seen or heard of in Vineyard sound or Buzzards bay since 1894; but formerly it was quite common and was often caught while line-fishing for tautog and scup.

Family GERRIDAE

Mojarras

Genus EUCINOSTOMUS Baird & Girard

Interhaemal bone of the second anal spine greatly modified, expanded into a hollow cylinder, into which the posterior end of the air bladder enters. Preopercle and preorbital entire; body comparatively elongate, subelliptic in form; anal spines three; the second anal spine and fourth dorsal spine not greatly enlarged. Species numerous in warm seas, remarkable for the structure of the second interhaemal, which is formed somewhat as in Calamus, but much more modified than in the latter genus.

276 Eucinostomus gula (Cuv. & Val.)

Mojarra de Ley; Silver Jenny

Gerres gula Cuvier & Valenciennes, Hist. Nat. Poiss. VI, 464, 1830, Martinique; Günther, Cat. Fish. Brit. Mus. I, 346, 1859.

Eucinostomus argenteus Baird & Girard, 9th Smithson. Rep. 345, 1855, Beesley's Point, N. J.

Gerres argenteus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 584, 1883; Bean, Bull. U. S. F. C. VII, 138, 1888, Great Egg Harbor Bay, N. J.

Eucinostomus gula Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1370, 1898; H. M. Smith, Bull. U. S. F. C. 1897, 101, 1898; Bean, 52d Ann. Rep. N. Y. State Mus. 106, 1900.

Body elliptic, compressed, back moderately elevated, the greatest depth contained two and two fifths times in total length without caudal. Head short, pointed, its length three tenths of total without caudal; mouth small, the maxillary reaching slightly past the vertical from the front of orbit; exposed portion of maxillary nearly oblong, its length twice its width, and equal to one fourth or one fifth the length of the head; preorbital and preopercle entire; snout two sevenths and interorbital width one third length of head; eye one third length of head. Gill rakers small and weak, seven below the angle of first arch; premaxillary groove scaly in front, posterior part naked forming a sort of pit. Longest dorsal spine two thirds as long as head. Second anal spine shorter and stronger than third, about three tenths as long as the head. Ventrals reach nearly to vent, five sevenths as long as head. Pectorals reach front of anal, and equal one third of total length without caudal. Second interhaemal hollow and enlarged.

D. IX, 10; A. III, 8; scales 5–42 to 45–9; vertebrae 9+15.

Color silvery, greenish, darker above; no distinct longitudinal lines except in very young; upper margin of spinous dorsal more or less black; dorsal and anal fins dusky; other fins pale.

The silver jenny occurs from Cape Cod to Brazil and the West Indies; only the young come far north in summer. The species reaches a length of 5 inches and is used for bait.

At Woods Hole Mass., writes Dr Smith, the species is usually very uncommon. In 1897 five specimens were taken at one seine haul in Quisset harbor on August 14; two in the same

locality September 7, and one in Eel Pond on September 23; all of these were 1 to 2 inches long. On October 5 the fish was abundant in Quisset harbor.

Young fish of this species were obtained in abundance at Beesley's Point, Somers Point, and Ocean City N. J. in August 1887. No adults were seen.

The only individual observed in Great South bay was a very small one, seined in Clam Pond cove, Aug. 22, 1898. Diligent search was made for the species in 1901, but no specimens were taken.

Family KYPHOSIDAE

Rudder fishes

Genus KYPHOSUS Lacépède

Body elongate-ovate, regularly elliptic, moderately compressed; head short, with blunt snout; eye large; mouth small, horizontal; maxillary barely reaching front of eye; each jaw with a single series of rather narrow obtusely lanceolate incisors, implanted with compressed conspicuous roots posteriorly; behind these a narrow band of villiform teeth; fine teeth on vomer, palatines, and tongue. Branchiostegals seven; gill rakers long. Preopercle obtusely serrate; preorbital narrow, covering but little of the maxillary. Squamation very complete, the space between and about the eyes being the only naked part; scales smallish, thick, ctenoid, 60 to 70 in the lateral line, which is continuous; similar scales entirely covering the soft parts of the vertical fins, and extending upon the paired fins. Dorsal fin low, with about 11 spines, which are depressible in a groove of scales, the fin continuous, but the last spines low, so that a depression occurs between the two parts of the fin, the bases of the spinous and soft parts about equal; soft dorsal rather low in front, not falcate, pointed behind; anal similar to soft dorsal, with three spines; caudal fin moderately forked; pectoral fins small, ventrals well behind them. Intestinal canal long; pyloric caeca very numerous. Vertebrae 9 or 10+15 or 16 = 25.

277 Kyphosus sectatrix (Linnaeus)

Bermuda Chub

Perca sectatrix LINNAEUS, Syst. Nat. ed. XII, 486, 1766.

Pimelepterus boscii CUVIER & VALENCIENNES, Hist. Nat. Poiss. VII, 258, pl. 187, 1831; DE KAY, N. Y. Fauna, Fishes, 100, pl. XX, fig. 56, 1842, copied from CUV. & VAL.; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 561, 1883.

Kyphosus sectatrix JORDAN & FESLER, Rept. U. S. F. C. 1889 to 1891, 525, 1893; BEAN, Bull. Am. Mus. Nat. Hist. IX, 366, 1897; H. M. SMITH, Bull. U. S. F. C. 1897, 101, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1387, 1898, pl. CCXIX, fig. 559, 1900.

Body ovate-elliptic, somewhat compressed, its greatest hight two fifths of the total length without caudal; the least depth of caudal peduncle nearly one half length of head. Head short, one fourth of total length without caudal; snout short; mouth small, the maxillary reaching to below front of orbit; teeth 35 to 40 on each side, their horizontal process not much longer than the vertical; width of interorbital space two fifths length of head; eye equal to snout, and more than one fourth length of head; top and sides of head finely scaled; interorbital region gibbous; preopercle serrulate; gill rakers long. Longest dorsal spine equals snout and is nearly one fifth depth of body; longest ray of soft dorsal two sevenths as long as the head. The second anal spine is about two thirds as long as the eye; the longest anal ray is one third as long as the head. Caudal deeply forked, the middle rays about one half as long as the outer, which are nearly as long as the head. Pectoral two thirds as long as the head, and equal to ventral, which reaches to below the ninth spine of the dorsal. Soft dorsal and anal closely scaled; most of caudal scaly.

D. XII, 12; A. III, 11; V. I, 5; P. i, 16; scales 10–66–16; vertebrae 9+16.

Color in life dusky or steel gray, very slightly bluish, not much paler below; the edges of each row of scales on back and sides slightly brassy so that very faint yellowish stripes alternate with bluish ones of about equal width; the stripes thus formed vary from 25 to 34 in number. A diffuse pale stripe below the eye; a yellowish one above and below this; fins all dull grayish; ventrals and anal blackish; edge of opercle slightly darker.

The Bermuda chub grows to the length of 18 inches. It ranges from Cape Cod to the West Indies, the Gulf of Mexico, across the ocean to the Canary Islands, and is accidental in the Mediterranean. Its name of rudder fish refers to its habit of following vessels, presumably to secure the waste food thrown from them. The fish is said to have game qualities.

At Woods Hole Mass. according to Dr Smith, the species is not rare in summer and fall and has occasionally been found in April; it is sometimes taken among gulf weed at the surface. Only young specimens, up to 6 inches long, have been secured there.

The Bermuda chub is a rare fish in Gravesend bay, but was found there in October 1896, and in September 1897. It has great endurance in captivity and will survive the winter in artificially heated water.

Family SCIAENIDAE

Croakers

Genus CYNOSCION Gill

Body elongate, little compressed, the back not elevated. Head conical, rather pointed; mouth very large, terminal, not very oblique, the lower jaw projecting, the symphysis produced, the angle at base of maxillary not prominent. Maxillary very broad. Teeth sharp, not closely set, in rather narrow bands; tip of the lower jaw without canines; upper jaw with two long canines, one of which is sometimes obsolete; canines tapering from base to tip; lateral teeth of lower jaw larger than anterior. Preopercle with its membranaceous edge serrulate, the bone entire. Lower pharyngeal bones separate, their teeth all pointed. Gill rakers strong, rather long. Vertebrae about 14+10 (instead of 10+14 as in sciaenoids generally). Pseudobranchiae well developed; dorsal spines slender, the fins closely contiguous; anal spines one or two, very feeble, the soft rays seven to 13; second dorsal long and low, more than twice length of anal; ventrals inserted below pectorals, the pubic bone long and strong; caudal fin subtruncate or lunate. Large fishes chiefly of the waters of America, closely related to the Old World genus Otolithus, from which they are distinguished

by the absence of canines in the lower jaw. All of them rank high as food fishes; the flesh is rich, but in some species tender and easily torn, hence the popular name weakfishes.

Subgenus CYNOSCION

278 Cynoscion regalis (Bloch & Schneider)

Weakfish; Squeteague

Johnius regalis BLOCH & SCHNEIDER, Syst. Ichth. 75, 1801, New York.

Roccus Comes MITCHILL, Rep. Fish. N. Y. 26, 1814, New York.

Labrus squeteague MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 396, pl. 2, fig. 6, 1815, New York.

Otolithus regalis CUVIER & VALENCIENNES, Hist. Nat. Poiss. V, 67, 1830; DE KAY, N. Y. Fauna, Fishes, 71, pl. 8, fig. 24, 1842; GÜNTHER, Cat. Fish. Brit. Mus. II, 307, 1860.

Cynoscion regale GILL, Proc. Ac. Nat. Sci. Phila. 18, 1862; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 581, 1883; BEAN, Bull. U. S. F. C. VII, 140, pl. II, fig. 6, 1888; 19th Rep. Comm. Fish. N. Y. 257, pl. XIII, fig. 15, 1890.

Cynoscion regalis GOODE & BEAN, Bull. Essex Inst. XI, 17, 1879, Cape Ann; BEAN, Bull. Am. Mus. Nat. Hist. IX, 367, 1897; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1407, 1898, pl. CCXX, fig. 562, 1900; H. M. SMITH, Bull. U. S. F. C. 1897, 101, 1898; BEAN, 52d Ann. Rep. N. Y. State Mus. 106, 1900; SHERWOOD & EDWARDS, Bull. U. S. F. C. 1901, 29, 1901.

Body elongate, little compressed, its greatest depth contained four and one fourth times in the total length without caudal; the least depth of caudal peduncle one third length of head, which is three tenths of total length without caudal. Eye moderate, three fourths length of snout, and one fifth to one seventh length of head. Maxillary reaching to below hind margin of eye, its length nearly two fifths length of head. Teeth sharp, in narrow bands; canines large. Gill rakers long and sharp, 5 above and 11 below the angle of the first arch. The second and longest dorsal spine is two fifths as long as the head; the first spine is one third as long as the head; the last two spines are very short; the longest soft ray of the dorsal is one third as long as the head. Caudal lunate behind, the longest rays equal to the head without the snout. The anal base is as long as the snout and eye combined; the longest ray slightly exceeds the base of the fin. Pectoral about equal to postorbital part of head and about one sixth of total length without caudal.

Ventral about one half as long as the head, reaching to below the seventh spine of the dorsal.

D. X, I, 26 to 29; A. I, 11 to 13; scales 8–78–17, about 66 pores in lateral line.

Silvery, darker above and marked with many small, irregular dark blotches, some of which form undulating lines running downward and forward; back and head with bright reflections; dorsal and caudal fins dusky; ventrals, anal, and lower edge of caudal yellowish, sometimes speckled. The young show traces of a few dusky bands on the sides, one under the spinous dorsal being most plainly marked, and extending to below the median line.

The weakfish, so called in Dr Mitchill's *Fishes of New York*, appears also in his report as the squeteague and checouts, the former being a Narragansett Indian name and the latter derived from the Mohegans. The Narragansett name is sometimes spelled scuteeg. Chickwick is the Connecticut name for the species; on Cape Cod, because of the sound produced by the fish, it is called the drummer; large weakfish in Buzzards bay are termed yellow fins. In Great Egg Harbor bay the name bluefish is applied to it, notwithstanding the presence of the real bluefish (P o m a t o m u s). On our southern coast we hear the names trout, with its variations gray trout, sea trout, shad trout, sun trout and salt-water trout. The latter name is used to distinguish it from the fresh-water trout of the southern states, which is the black bass. Dr Mitchill thus accounts for the name weakfish: "He is called weakfish, as some say, because he does not pull very hard after he is hooked; or, as others allege, because laboring men who are fed upon him are weak by reason of the deficient nourishment in that kind of food." De Kay explains the name from the feeble resistance the fish makes on the hook and the facility with which it breaks away from it by reason of its delicate structure. At the time of De Kay's writing in 1842, and for some years previously, the weakfish was present on our coast in diminished numbers. The bluefish was then present in abundance and the disappearance of the

weakfish was supposed to be connected with the reappearance of the bluefish. A similar observation was made by Dr Storer on the Massachusetts coast. Again, at Woods Hole Mass. in 1900, the weakfish was remarkably abundant, the traps at Menemsha having taken 10,000 in a single day; the bluefish, on the other hand, was unusually scarce during the entire season, not over 50 having been recorded from the adjacent bay and sound.

The weakfish ranges from the Bay of Fundy to the east coast of Florida. It fluctuates in abundance from year to year. The late Capt. N. E. Atwood is authority for the statement that in 1845 the weekly supply in the New York markets was not above 1000 pounds.

The species feeds in the channels upon shrimp, crabs and small fish. In Great South bay we found them eating large quantities of anchovies, and the same observation was made in one of the inlets of Great Egg Harbor bay, N. J. The fish enters the mouths of rivers and migrates freely with the tide.

The species swims in large schools near the surface and is very voracious, destroying the young even of its own kind. A specimen of about 4 pounds, taken at Islip October 1, 1890, had in its stomach a weakfish weighing about 6 ounces. Fish of 4 pounds and a little larger were moderately abundant at this date.

Weakfish spawn in New York waters in May, and at Cape Cod about the first of June. The egg is $\frac{1}{10}$ inch in diameter and hatches in two days at an average temperature of 60° F. It is buoyant and, under natural conditions, is subject to the influence of wind and current. The spawning season is evidently prolonged in some localities; in Great Egg Harbor bay, for example, young weakfish only $1\frac{1}{8}$ inches long were taken in August, that is, several months after spawning began.

The earliest arrival in New York was on May 12, 1889, at Great Hills, Gifford, Staten Island. During the latter part of August 1889, the west channel of Great South bay furnished great numbers of weakfish. The young were found in Blue Point cove late in September; also some half grown individuals.

The fish are in their finest condition during the fall migration in September and October. On September 21, 1887, two men caught 200, including some very large ones, on a single tide near the inlet of Great Egg Harbor bay, N. J. The most favorable tide for catching this species is generally considered the latter half of the flood and first half of the ebb. At night the weakfish runs up the creeks to feed in the salt meadows and will take the hook freely.

Some of the best baits for the weakfish are the common shrimp, soft or shedder crabs, pieces of clam and common mussel, the white skin of the throat of weakfish, and sometimes the eye of this species; other good baits are silversides and anchovies. In Great South bay the fish are taken extensively in pound nets and gill nets. The gill nets are set in the shape of a horseshoe, and the attending sloop sails back and forth across the open end of the horseshoe, one of the crew meanwhile beating the deck with his heels to frighten the fish into the nets. This method, called drumming, is in great disfavor among those who follow other modes of fishing.

In 1901, young weakfish were seldom taken in Great South bay and only two localities—Duncan's creek and Smith's Point —furnished them in very small numbers. Adult fish, however, were remarkably abundant and were caught in many parts of the bay.

The weakfish endures captivity very well and can be kept during winter in water of the proper temperature. The species is said to reach the weight of 30 pounds.

279 **Cynoscion nebulosus** (Cuv. & Val.)

Spotted Weakfish; Sea Trout

Labrus squeteague var. *maculatus* Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 396, 1815, New York; not *Labrus maculatus* Bloch.

Otolithus nebulosus Cuvier & Valenciennes, Hist. Nat. Poiss. V, 79, 1830.

Otolithus carolinensis Cuvier & Valenciennes, Hist. Nat. Poiss. IX, 475, 1833, South Carolina; De Kay, N. Y. Fauna, Fishes, 72, 1842, extralimital; Holbrook, Ichth. S. C. ed. 1, 133, pl. 19, fig. 2, 1856; Günther, Cat. Fish. Brit. Mus. II, 306, 1860, New York.

Cynoscion maculatum Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 581, 1883.

Cynoscion nebulosus JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1469, 1898, pl. CCXXI, fig. 563, 1900.

Body elongate, compressed, its greatest depth two ninths of the total length without caudal; the least depth of caudal peduncle one half postorbital length of head. Head long, two sevenths of total length without caudal; snout long and acute, about two sevenths as long as the head; eye small, about one seventh as long as head; maxillary reaching to below hind margin of orbit, as long as snout and eye combined; canines strong; lower pharyngeals narrow, each with seven or eight series of short teeth, the inner enlarged; gill rakers short and thick, about 4+7 on first arch; maxillary, preorbital, and lower jaw naked. Spinous dorsal base as long as postorbital part of head; first dorsal spine one half as long as second, which is one third length of head; third and longest spine nearly one half as long as head; spines decreasing rapidly in length from the fifth to the last, which is minute; soft dorsal base one third of total length without caudal; the longest soft ray one third length of base. Caudal shallow concave, the middle rays one half as long as the head. Anal base short, one third as long as the head; longest anal ray one half depth of body. Pectoral short, reaching to below sixth spine of dorsal. Ventral longer than pectoral, one sixth of total without caudal, reaching to below end of spinous dorsal. Ventral appendage nearly as long as the eye. D. X, I, 24 to 28; A. I, 10 to 12; V. I, 5; P. I, 15; pores in lateral line about 90.

Body silvery with bright reflections; numerous black spots on back, beginning under the spinous dorsal; soft dorsal and caudal similarly spotted, the largest spots smaller than pupil; anal fin dusky.

The spotted weakfish is a better food fish than the common northern species; it ranges from New York to Texas, but is rare north of Virginia.

Genus LARIMUS Cuvier & Valenciennes

Body rather elongate, compressed; skull firm, not greatly cavernous; interorbital space rather narrow; preorbital flattish, not turgid; upper jaw with the usual slits and pores little de-

veloped; no barbels; no canines; snout very short; mouth large, terminal, very oblique or even vertical, the lower jaw projecting; teeth minute, equal, uniserial or partly biserial above; preopercle entire or nearly so, without bony teeth. Scales moderate, subequal. Pseudobranchiae well developed. Fins essentially as in Bairdiella, the second dorsal long, the anal short, its spines moderate or small; fins not thickened by accessory scales. Gill rakers long and slender. Vertebrae 10+14 = 24. Silvery fishes, all American.

Subgenus LARIMUS

280 **Larimus fasciatus** Holbrook

Banded Larimus

Larimus fasciatus Holbrook, Ichth. S. C. 153, pl. 22, fig. 1. 1856. Charleston; Günther, Cat. Fish. Brit. Mus. II, 269, 1860; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 578, 1883; Jordan & Eigenmann, Rep. U. S. F. C. for 1886, 376, 1889; Bean, Bull. Am. Mus. Nat. Hist. IX, 367, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 101, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1424, 1898.

Body oblong, compressed, ventral outline nearly straight, dorsal outline considerably arched; the depth of the body is contained about three times in the length. Snout very short, much less than diameter of the large eye; mouth large, very oblique, maxillary reaching to posterior margin of orbit; the length of the head is contained three and one half times in that of the body. Tip of mandible on level of lower part of pupil; second anal spine small; pectoral fin short; caudal subtruncate. D. X–I, 24; A. II, 6; Lat. l. about 62.

Silvery gray, clouded above; sides marked with about seven nearly vertical dusky bars, running from back to below the lateral line. South Atlantic coast and southward; rare. An individual was captured in Gravesend bay July 25, 1895, and another one August 2 of the same year. These fed freely, and were kept in a healthy condition till January 16, 1896, when the low temperature of the water killed them. The fish is not common anywhere, and had not before been recorded north of Chesapeake bay, except a single example which was taken at Woods Hole Mass. on August 13, 1889; the specimen was caught in a trap at the breakwater, Buzzards bay.

Genus BAIRDIELLA Gill

This genus is characterized by the oblique mouth, little cavernous skull, few rows of small teeth, slender gill rakers, and the preopercle armed with a plectroid spine. It is certainly a very natural group, and worthy of recognition as a distinct genus, though its relationships with Ophioscion and specially with Stellifer are very close. The numerous species are all American, all small in size and silvery in coloration, and some of them are remarkable for the great size of the second anal spine. In others this spine is quite small. These variations among species unquestionably closely allied show how slight is the systematic value to be attached to the size of this spine.

Subgenus BAIRDIELLA

281 Bairdiella chrysura (Lacépède)

Yellowtail; Silver Perch

Dipterodon chrysurus LACÉPÈDE, Hist. Nat. Poiss. III, 64, 1802, South Carolina.

Bodianus argyroleucus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 417, pl. 6, fig. 9, 1815, New York.

Corvina argyroleuca CUVIER & VALENCIENNES, Hist. Nat. Poiss. V, 105, 1830; DE KAY, N. Y. Fauna, Fishes, 74, pl. 18, fig. 51, 1842, New York; GÜNTHER, Cat. Fish. Brit. Mus. II, 299, 1860.

Homoprion xanthurus HOLBROOK, Ichth. S. C. ed. 1, 170, pl. 24, 1856 (not *Lciostomus xanthurus* LACÉPÈDE).

Sciaena punctata JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 570, 1883.

Sciaena chrysura JORDAN & GILBERT, op. cit. 933, 1883.

Bairdiella chrysura GOODE, Fish. & Fish. Ind. U. S. I, 375, pl. 126, 1884; BEAN, Bull. U. S. F. C. VII, 141, pl. I, fig. 9, 1888; 19th Rep. Comm. Fish. N. Y. 259, 1890; Bull. Am. Mus. Nat. Hist. IX, 367, 1897; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1433, 1888, pl. CCXXII, fig. 566, 1900; BEAN, 52d Ann. Rep. N. Y. State Mus. 106, 1900.

Body oblong, compressed, rather robust, its greatest depth one third of total length without caudal; least depth of caudal peduncle one eighth of total without caudal. Head compressed, conical, not depressed nor broadened, its length three tenths of total without caudal; eye equal to snout and about one fourth length of head; interorbital region depressed, transversely convex, narrower than the eye; mouth rather large, somewhat oblique, jaws about equal in front, maxillary long, reaching

nearly to below hind margin of orbit, its width posteriorly nearly one third of its length; both jaws with stout recurved teeth, behind which, in the upper jaw, are a few series of smaller teeth; mandibulary teeth mostly in one series outside of which are a few smaller teeth; preopercle strongly serrate or spinous at its angle; gill rakers slender, moderately long, 8+16 on first arch; lower pharyngeals small, with sharp teeth. Spinous dorsal high in front, triangular, the first spine very short, the fourth longest, equal to postorbital part of head; base of soft dorsal one third of total length without caudal, longest ray equal to snout and eye combined, last ray two thirds as long as the eye. Caudal concavo-convex, the middle rays equal to longest dorsal spine. Anal base three eighths as long as the head; longest anal ray equal to snout and eye combined; first anal spine very short, second two fifths as long as the head. Soft dorsal and anal fins considerably scaly. Pectoral and ventral of equal length, one fifth of total without caudal, the pectoral scarcely reaching to below end of spinous dorsal. D. XI, I, 22; A. II, 9 or 10; scales 8–50 to 54–11.

Greenish above, silvery below, each scale with series of dark punctulations through the center, usually very conspicuous, sometimes obscure, these forming narrow somewhat irregular streaks along the sides; fins plain, the caudal yellowish.

Dr Mitchill describes this fish as the silver perch, and De Kay explains the origin of this name from the resemblance which the yellowtail bears in its appearance and habits to the common white perch. At Pensacola Fla. the name mademoiselle is applied to the species. In Great South bay we heard the name lafayette given it, but this belongs more properly to the spot **Liostomus xanthurus**.

The yellowtail occurs on our coast from Cape Cod to Florida. It was a common fish in Great South bay in September 1890, and during the early part of October, occurring at Blue Point cove, at the Blue Point Lifesaving station, Great River beach and Fire Island. It is frequently taken in the pounds. In 1898, the young were found in abundance at Nichols's Point, Great

South bay, September 1. In 1901, the species was not observed at all during a season extending from the middle of July to the middle of October.

The breeding season must continue into early summer as many young fish, from 1 inch to 2½ inches long, were obtained in Great Egg Harbor bay, N. J. early in August.

The young of the silver perch are found every summer in Gravesend bay, and adults are to be seen occasionally. On September 8, 1896, Mr De Nyse took an example 1¼ inches long with a shrimp net in eelgrass back of the flats at extreme low tide. Pools containing 2 feet of water are common here, and many species of fish become imprisoned in them. In August Mr W. I. De Nyse has captured a half dozen adult Hippocampus in such localities. On October 5, 1896, and again in the fall of 1897, the silver perch was obtained in the bay.

The species seldom exceeds 10 inches in length, but is regarded as an excellent panfish, and is secured in enormous numbers.

Genus SCIAENOPS Gill

This genus is close to Ophioscion, from which it differs in the loss of its preopercular armature with age, the serrate edge of the bone becoming entire. The caudal fin is truncate or concave, the soft dorsal scaleless; the slits and pores of the upper jaw are well developed and the single species reaches a very large size. The group is not well separated from Ophioscion on the one hand, or from Sciaena on the other, but its retention seems to be convenient.

282 Sciaenops ocellatus (Linnaeus)

Red Drum; Channel Bass

Perca ocellata LINNAEUS, Syst. Nat. ed. XII, 483, 1766, South Carolina.
Sciaena imberbis MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 411, 1815, New York.
Corvina ocellata CUVIER & VALENCIENNES, Hist. Nat. Poiss. V, 134, pl. 108, 1830; DE KAY, N. Y. Fauna, Fishes, 75, pl. 21, fig. 61, 1842, New York; HOLBROOK, Ichth. S. C. ed. 1, 149, pl. 21, fig. 2, 1856.
Johnius ocellatus GIRARD, U. S. Mex. Bd. Surv. 14, pl. 8, figs. 1-4, 1859.
Sciaena ocellata GÜNTHER, Cat. Fish. Brit. Mus. II, 289, 1860, America; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 571, 1883.

Sciaenops ocellatus BEAN, Bull. Am. Mus. Nat. Hist. IX, 367, 1897, New Jersey; H. M. SMITH, Bull. U. S. F. C. 1897, 101, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1453, 1898, pl. CCXXII, fig. 567, 1900.

Body elongate, robust, its greatest depth one fourth of total length without caudal, least depth of caudal peduncle about one third of greatest depth; back somewhat arched; profile of head convex. Head rather long, three tenths of total length without caudal; eye small, about one seventh as long as the head; snout obtuse, two ninths as long as the head. Mouth large, nearly horizontal, the lower jaw rather shorter than the upper; the maxillary reaching to below the hind border of the orbit, its length more than two fifths length of head; bands of villiform teeth in both jaws, the outer teeth of the upper jaw much enlarged; lower jaw with subequal teeth. Preopercle strongly serrate on its bony margin in the young, entire in large individuals and with the edge of the bone covered by skin. Gill rakers 5+7 on first arch, shorter than the diameter of the pupil. Spinous dorsal triangular, the first spine minute, the fourth, and longest, four ninths as long as the head, the last two thirds as long as the eye; base of soft dorsal twice as long as that of spinous dorsal, the longest ray one third as long as the head. Anal base short, one third as long as the head, two thirds as long as longest anal ray; the end of the anal base is under the 17th ray of soft dorsal, second anal spine about three eighths as long as the head; caudal nearly truncate, the middle rays one half as long as the head. Pectoral equals postorbital part of head, the fin extending to below the end of spinous dorsal. Ventral equal to pectoral, and not reaching nearly to vent. Scales of the breast embedded, cycloid; no scales on soft dorsal except in a very narrow strip at its base. D. X, I, 24 to 25; A. II, 8; scales 4–45 to 55–10 to 12. Color grayish silvery, iridescent; often washed with coppery red; each scale with a center of dark points forming obscure undulating stripes along the rows of scales; a jet black ocellated spot about as large as the eye at base of caudal above; sometimes two or more such spots are present; the body occasionally covered with ocelli.

The red drum is one of the largest of the food fishes of the southern waters, reaching the length of 5 feet and the weight

of 75 pounds. It inhabits the Atlantic coast from New York to Texas, and has once been taken near Cape Cod.

A red drum, or spotted bass, weighing 14 pounds, was obtained by Mr E. G. Blackford from New Jersey, and was purchased alive for the New York aquarium. At the time of writing (December 11, 1897) it is in the central pool, and is, apparently, in perfect health. It swims sometimes immediately under the sand shark. Its food consists of large pieces of herring, which it takes readily.

The only specimen known to have been taken at Cape Cod was caught in a trap in Buzzards bay at the breakwater in 1894. The example is 34 inches long and weighs about 14 pounds. On account of the ocellated markings at the base of the caudal fin it has sometimes been called the branded drum.

Genus LEIOSTOMUS Lacépède

Body oblong, ovate, the back compressed; head obtuse; mouth small, horizontal, the upper jaw with a band of feeble teeth, the lower nearly or quite toothless; slits and pores of upper jaw well developed; lower pharyngeals separate, the teeth paved; preopercle with a membranaceous border; dorsal spines 10, slender, rather high, the last connected with the soft rays; soft dorsal and anal long; anal spines two, the second not large; caudal fin emarginate; gill membranes slightly connected; gill rakers slender. This genus is distinguished from Sciaena chiefly by the obsolescence of the teeth in the lower jaw, and by the more paved teeth of the pharyngeals. The soft rays of the dorsal fin and specially of the anal are more numerous than in related groups. One species.

283 Leiostomus xanthurus Lacépède

Spot; Lafayette

Leiostomus xanthurus LACÉPÈDE, Hist. Nat. Poiss. IV, 439, pl. 10, fig. 1, 1802, Carolina; CUVIER & VALENCIENNES, Hist. Nat. Poiss. V, 142, 1830; DE KAY, N. Y. Fauna, Fishes, 70, 1842, extralimital; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 574, 1883; BEAN, Bull. U. S. F. C. VII, 141, 1888; 9th Rep. Comm. Fish. N. Y. 260, 1890; Bull. Am. Mus. Nat. Hist. IX, 367, 1897; EUGENE SMITH, Proc. Linn. Soc. N. Y. 1897, 39, 1898; MEARNS, Bull. Am. Mus. Nat. Hist. X, 321, 1898; H. M. SMITH, Bull. U. S. F. C. 1897, 101, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1458, 1898, pl. CCXXIII, fig. 569, 1900.

Mugil obliquus MITCHILL, Rep. Fish. N. Y. 16, 1814, New York; Trans. Lit. & Phil. Soc. N. Y. I, 405, 1815, New York.
Leiostomus obliquus DE KAY, N. Y. Fauna, Fishes, 69, pl. 60, fig. 195, 1842.
Sciaena obliqua GÜNTHER, Cat. Fish. Brit. Mus. II, 288, 1860.
Sciaena xanthurus GÜNTHER, op. cit. 288, 1860.

Body short, deep, compressed, its greatest depth one third, or more than one third, of the total length without the caudal; least depth of caudal peduncle three sevenths length of head; back in front of dorsal compressed to a sharp edge; profile steep, convex, depressed over the eyes; dorsal outline convex, highest at dorsal origin. Head short, its length contained three and one third to three and two thirds times in the total without caudal; snout short and very blunt, about two sevenths as long as the head and slightly longer than the eye. Mouth small, inferior, horizontal; maxillary rather more than one third length of head, extending to below middle of pupil; lower jaw toothless in the adult, upper jaw with a series of narrow minute teeth; gill rakers short, slender, 8+22 on the first arch; lower pharyngeals small, with three series of molars posteriorly and many villiform teeth anteriorly; preopercle entire; preorbital about equal to eye in width. Spinous dorsal triangular, but rounded at tip, the first spine very slender and very closely attached to the second, the third and fourth longest, three fifths as long as the head, the last two spines very short, only about as long as the pupil. Soft dorsal long and low, the base twice as long as that of spinous dorsal, the longest ray three eighths as long as the head. Caudal forked, the middle rays one half as long as the head. Anal elevated in front, low behind, the longest ray more than one half as long as the head, the last shorter than the eye; the second anal spine as long as the eye; the first spine very small. Pectoral large, extending to below the sixth ray of second dorsal, nearly as long as the head. Ventral as long as the head without snout, not reaching nearly to vent. Scales small, ctenoid, extending on caudal and base of pectorals, but not on other fins; soft dorsal, however, has a sheath at base formed by a single series of scales; scales below lateral line in oblique series. Lateral line little curved anteriorly.

D. X, I, 30 to 32; A. II, 12; P. I, 17; scales 9-60 to 70-12 to 14.

Color bluish above, silvery below; about 13 to 15 narrow dark lines extending from the dorsal fins downward and forward to below the lateral line; a roundish black humeral spot about two thirds as long as the eye; fins plain olivaceous.

This little fish was formerly known on the New York coast as lafayette. Mitchill calls it the little porgee. According to De Kay its appearance on the New York coast in the summer of 1824 happened to coincide with the arrival of General Lafayette and his name was bestowed upon the species. The name spot is derived from the presence of a dark blotch about as big as the eye near the root of the pectoral fin. Other names for the species are goody, oldwife, roach and chub.

The spot is found from Cape Cod to Florida and is sometimes abundant as far north as New York. In Great South bay several specimens were taken early in October in Great river. A single example was seen among some fishes taken in a pound-net in Islip, Oct. 1, 1890. In 1898 the species was not obtained by the writer, and in 1901 only a few specimens, mostly adults, were secured at Quantic bay, Duncan's creek, and Widow's creek.

Rather common in Gravesend bay from July to as late as December, and is well adapted to captive life. It is most abundant usually in September.

Dr Mearns states that the fish, locally known as the sand porgee, is of frequent occurrence in summer in the Hudson river and its estuaries. H. M. Smith records it as common in the fall in the vicinity of Woods Hole Mass. leaving in October or November, when the water temperature reaches 45° F. All the specimens observed there were about 6 inches long.

It is a small fish, seldom exceeding 10 inches in length, but is one of the favorites among the panfishes. The spot feeds on the bottom on small invertebrates, and can be taken readily with hook and line. In Great South bay it is caught in seines and pound nets. It ascends creeks into brackish water and is a common associate of the white perch. In Great Egg Harbor

bay it is extremely common in summer and is sometimes known as porgee.

Genus MICROPOGON Cuvier & Valenciennes

Body moderately elongate, compressed, somewhat elevated; preopercle strongly serrate; teeth in villiform bands, the outer row in the upper jaw enlarged; lower jaw with a row of minute barbels on each side; gill rakers short, thickish; spinous dorsal rather short of 10 or 11 stoutish spines; second anal spine moderate; caudal fin double truncate; lower pharyngeals narrow, distinct, with sharp, conical teeth; air bladder with long horns. A well marked genus, the species all American, allied to Ophioscion and Sciaenops, but distinguished by the presence of barbels; species all closely related, similar in form, size, and color.

284 Micropogon undulatus (Linnaeus)

Croaker

Perca undulata LINNAEUS, Syst. Nat. ed. XII, 483, 1766, South Carolina.

Bodianus costatus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 417, 1815, New York.

Micropogon lineatus CUVIER & VALENCIENNES, Hist. Nat. Poiss. V, 215, pl. 119, 1830, New York.

Micropogon costatus DE KAY, N. Y. Fauna, Fishes, 83, pl. 72, fig. 230, 1842.

Micropogon undulatus CUVIER & VALENCIENNES, Hist. Nat. Poiss. V, 219, 1830; DE KAY, N. Y. Fauna, Fishes, 84, 1842, extralimital; HOLBROOK, Ichth. S. C. ed. 1, 145, pl. 21, fig. 1, 1856; GÜNTHER, Cat. Fish. Brit. Mus. II, 271, 1860, in part; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 575, 1883; BEAN, Bull. Am. Mus. Nat. Hist. IX, 368, 1897; H. M. SMITH, Bull. U. S. F. C. 1897, 101, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1461, 1898, pl. CCXXIV, fig. 570, 1900.

Body rather elongate, little compressed, its greatest hight equal to length of head, and two sevenths of total length without caudal; caudal peduncle short, its least depth equal to snout, and about one third length of head. Head long, two sevenths of total length without caudal, the snout prominent, obtuse, nearly twice as long as the eye, which is one fifth as long as the head. Mouth rather large, nearly horizontal, the maxillary reaching to below front of eye. Preopercle strongly serrate, the spines near angle diverging. Dorsal fins nearly separate, the spinous dorsal triangular, the first and last spines

shorter than eye, the third and fourth longest, equal to snout and eye combined, the base of the fin as long as the ventral. Soft dorsal long and low, one fourth longer than head, the longest ray one third as long as head. Caudal slightly produced in the middle, the middle rays one half as long as head. Anal base three eighths as long as head; the first spine minute, second spine one fourth as long as head, first ray about one half length of head, last ray two ninths as long as head. Pectoral long, reaching beyond origin of soft dorsal. Ventral one sixth of total length without caudal, not reaching nearly to vent. Interorbital width somewhat exceeds diameter of eye.

D. X, I, 27 to 30; A. II, 8; V. I, 5; P. I, 16; scales 9–60–12; pyloric caeca eight; gill rakers 7+16.

Color grayish silvery, with bright reflections; sides and back with narrow, irregular, undulating lines of dots; dorsal fins with three lines of dots along base.

The croaker inhabits the east coast of the United States, ranging from Cape Cod to Texas; it is not very common north of the Chesapeake. It grows to the length of 15 inches and is an important food fish. The fish was described by Mitchill but was unknown to De Kay from personal observation. Though known in Gravesend bay, the species is a very uncommon one there. The only specimen recorded at Woods Hole Mass. is 15 inches long; it was taken in a trap at the breakwater in Buzzards bay on Sep. 9, 1893.

Genus MENTICIRRHUS Gill

Body comparatively elongate, little compressed; head long, subconic, the bluntish snout considerably projecting beyond the mouth; mouth small, horizontal, both jaws with bands of villiform teeth, the outer teeth in the upper jaw more or less enlarged; chin with a single stoutish barbel; preopercle with its membranaceous edge serrulate; gill rakers short and tubercular or obsolete; dorsal spines high, slender, 10 or 11 in number (13 in Cirrimens); second dorsal long and low; caudal fin with the lower angle rounded, the upper sharp; anal fin with a single weak spine; no air bladder. Lower pharyngeals separate,

the teeth varying from sharp to very obtuse. This genus is one of the most strongly marked in the family. It has been confounded by all European writers with Umbrina, with which it has not very much in common except the presence of the barbel at the chin. All the species are American, and all bottom fishes. The low, elongate body, the large pectorals, and the obsolete air bladder are all characters related to this peculiarity of habit.

Subgenus MENTICIRRHUS Gill

285 Menticirrhus saxatilis (Bloch & Schneider)

Kingfish; Whiting; Sea Mink

Johnius saxatilis BLOCH & SCHNEIDER, Syst. Ichth. 75, 1801, New York.
Sciena nebulosa MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 408, pl. 3, fig. 5, 1815.
Umbrina alburnus DE KAY, N. Y. Fauna, Fishes, 78, pl. 7, fig. 20, 1842.
Umbrina nebulosa GÜNTHER, Cat. Fish. Brit. Mus. II, 275, 1860; STORER, Hist. Fish. Mass. 46, pl. IX, fig. 4, 1867.
Menticirrhus nebulosus GOODE & BEAN, Bull. Essex Inst. IX, 17, 1879; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 577, 1883.
Menticirrhus saxatilis BEAN, Bull. U. S. F. C. VII, 141, pls. II, III, figs. 7 and 8, 1888; JORDAN & EIGENMANN, Rep. U. S. F. C. for 1886, 431, 1889; BEAN, 19th Rep. Comm. Fish. N. Y. 259, pl. XII, fig. 16, 1890; Bull. Am. Mus. Nat. Hist. IX, 368, 1897; H. M. SMITH, Bull. U. S. F. C. 1897, 101, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1475, 1898; BEAN, 52d Ann. Rep. N. Y. State Mus. 106, 1900.

Body robust, elongate, its greatest depth about two ninths of total length without caudal; the least depth of caudal peduncle one third length of head. Head one fourth to two sevenths of total length without caudal; snout one fourth as long as the head; eye small, two thirds as long as snout. Mouth large, the maxillary reaching to below middle of eye. Outer teeth of upper jaw not much enlarged. Spinous dorsal elevated, the third spine longest, two thirds as long as the head, reaching slightly past origin of soft dorsal; first spine minute, last two spines very short. Base of soft dorsal one third of total length without caudal; the longest ray less than one third length of head. Caudal concave above, convex below, the middle rays about one half as long as the head. Anal base under the middle portion of the soft dorsal, its length about equal to least depth of caudal peduncle, the spine one third as long as the pectoral, the longest

ray equal to snout and eye combined. Pectoral large, nearly as long as the head, reaching past origin of soft dorsal. Ventral one half as long as the head. Scales all ctenoid. D. X, I, 26 or 27; A. I, 8; scales 7 53-14.

Color dusky gray above, sometimes blackish, the back and sides with distinct dark oblique cross bands running downward and forward, the anterior one at the nape extending downward, meeting the second and thus forming a V-shaped blotch on each side; a dark lateral streak bounding the pale color of the belly, most distinct posteriorly, and extending on lower lobe of caudal; inside of gill cavity scarcely dusky; pectorals dark.

The kingfish, according to De Kay, was so named by the early English colonists because of its excellent flavor. The name hake is given to it in New Jersey and Delaware; in the Chesapeake it is sometimes called black mullet; in North Carolina, the sea mink; in the south it is the whiting or Bermuda whiting; on the Connecticut coast it is known as the tomcod.

The kingfish occurs northward to Cape Ann and south to the Gulf of Mexico. Large individuals are not common as far north as Cape Cod, but the young may be seen in moderate numbers in the summer months. They occur in abundance throughout Great South bay and near the inlet their number is increased. We have collected them at the mouth of Swan creek, in Blue Point cove, at the Blue Point Lifesaving station, Oak Island and Fire Island. An individual was obtained October 7, in the bay, and others were found during September. Adult kingfish used to be common in Great South bay, but in 1884 they were rare, according to Mr Erastus Gordon, of Patchogue. In 1898 only one adult was taken by the writer and that was found in Clam Pond cove, August 26. Young were seined at Fire Island inlet, Nichols's Point, Howell's Point, Blue Point cove, and in Peconic bay. In 1901, large kingfish were not uncommon in Great South bay, but the young were unusually rare, only two specimens measuring from $3\frac{3}{4}$ to 4 inches having been obtained; these were seined at Duncan's creek, September 14.

The kingfish was formerly abundant in Gravesend bay, but it seldom occurs there now.

The species evidently breeds at Woods Hole Mass. Dr Smith says that adults full of spawn are common there in June and uncommon after July 15. The young about an inch long appear in the middle of July, and the young are numerous on sandy beaches during the summer and till early October, when they leave, having attained a length of 4 or 5 inches. Some of the young are almost entirely black, while others of the same size taken at the same time show the color markings of the adults. The maximum weight there is about 2 pounds.

The species is a favorite in New York waters and well merits its reputation as a choice food fish. It takes the baited hook very readily. Hard clam, cut small, shedder crab, black mussels and various kinds of fish are good baits. It goes in schools and associates with the weakfish.

The name kingfish is said to have been given it in honor of the king by colonial New Yorkers, who esteemed the fish highly.

Genus POGONIAS Lacépède

Body short and deep, the dorsal outline much elevated, the ventral nearly straight. Mouth moderate, the upper jaw longest; teeth small, in villiform bands, the outer not enlarged; lower pharyngeal bones large, fully united, armed with strong paved teeth; lower jaw with numerous barbels, each about one half as long as the eye; preoperculum entire, with a membranaceous edge. Dorsal fins slightly connected, the spines high and strong; caudal fin subtruncate; first anal spine short, the second exceedingly large, nearly as long as the soft rays; pectorals and ventrals long; gill rakers short and bluntish. Pseudobranchiae large. Marine species, reaching a very large size, among the largest of the Sciaenidae, two species known.

286 **Pogonias cromis** (Linnaeus)

Drum

Labrus cromis LINNAEUS, Syst. Nat. ed. XII, 479, 1766, Carolina.

Pogonias fasciatus LACÉPÈDE, Hist. Nat. Poiss. III, 137, 1802; CUVIER & VALENCIENNES, Hist. Nat. Poiss. V, 210, pl. 118, 1830; DE KAY, N. Y. Fauna, Fishes, 81, pl. 14, fig. 40, 1842; GUNTHER, Cat. Fish. Brit. Mus. II, 270, 1860.

Mugil grunniens MITCHILL, Rep. Fish. N. Y. 16, 1814, New York.

Mugil gigas MITCHILL, Rep. Fish. N. Y. 16, 1814, New York.

Labrus grunniens MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 405, 1815.

Sciena fusca MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 409, 1815, New York.

Sciena gigas MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 413, 1815, New York.

Pogonias chromis CUVIER & VALENCIENNES, Hist. Nat. Poiss. V, 206, 1830; DE KAY, N. Y. Fauna, Fishes, 80, 1842; HOLBROOK, Ichth. S. C. ed. 1, 112, pl. 16, fig. 2, 1856; GÜNTHER, Cat. Fish. Brit. Mus. II, 270, 1860; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 568, 1883; BEAN, 19th Rep. Comm. Fish. N. Y. 261, pl. XIII, fig. 17, 1890.

Pogonias cromis BEAN, Bull. Am. Mus. Nat. Hist. IX, 368, 1897, Gravesend Bay; H. M. SMITH, Bull. U. S. F. C. 1897, 101, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1482, 1898, pl. CCXXV, fig. 573, 1900.

Body oblong, compressed, heavy forwards, its greatest depth two fifths to one third of total length without caudal; least hight of caudal peduncle one third length of head. Head large, its length about two sevenths of total without caudal; snout short, strongly declivous, a very shallow depression over the eyes, nape much arched. Lower jaw slightly shorter in front than upper; maxillary reaching to below middle of eye. Teeth in broad bands, the outer series in maxillary scarcely enlarged; lower pharyngeals large, completely united, covered with many blunt molars and a small patch of conical teeth at the outer posterior corner. Gill rakers 4+12 on first arch, very short and slender. Spinous dorsal triangular, the fourth and fifth longest, two fifths as long as the head, the spines rapidly diminishing in size to the front and rear, the first one being minute; the base of spinous dorsal as long as the head without the snout. Soft dorsal lower than spinous, the longest rays one third as long as the head. Anal base short, under second half of soft dorsal, the first spine minute, the second about one third as long as the head, the longest ray twice as long as the last ray and one half as long as the head. Caudal truncate, the middle rays about one half as long as the head. Pectoral long, reaching to below the fourth ray of soft dorsal, as long as the head. Ventral equal to postorbital part of head, reaching to below the origin of soft dorsal. Scales on breast small, others large. D. X, I, 21 to 22; A. II, 5 to 6; P. I, 17; V. I, 5. Scales 7–47 to 52–11.

Color grayish silvery, with five broad dark bars three of which extend upon the dorsal fins, these bars disappearing with age;

usually no oblique dark streaks along rows of scales above; fins dusky.

Dr Mitchill describes the drum under the names, black drum and red drum. The black drum which he described weighed 34 pounds. He had a specimen of 80 pounds, and states that he was credibly informed of one that weighed 101 pounds. The species, according to Dr Mitchill, was taken abundantly during the summer with line and net. The name drum, he says, is derived from the drumming noise made by the fish immediately after being taken out of water. "He swims in numerous shoals in the shallow bays on the south side of Long Island, where fishermen during the warm season can find them almost like a flock of sheep; is a dull sort of fish." The red drum he considered merely a variety of the black drum. Dr De Kay says of the species, which he calls the big drum: "They are gregarious, and frequently taken in great numbers by the seine during the summer along the bays and inlets of Long Island." De Kay adopted a different specific name for the young of this species, and called it the banded drum. Other names for this stage given by De Kay are: grunter, grunts, young drum and young sheepshead. He saw the young in September, and states that it is found in New York waters also in October and November. The adults, according to De Kay, are a coarse food, but the young are considered a great delicacy.

The drum is occasionally taken on our coast as far north as Cape Cod; southward it extends to the Gulf of Mexico.

The drum is an occasional summer visitor in Gravesend bay. In the fall of 1896, 14 young individuals, 8 inches long, were brought from there alive to the aquarium, and lived till February 10, 1897, when the low temperature of the water (38°) killed them. In the fall of 1897 none were seen in the bay.

In the vicinity of Woods Hole Mass. the drum is very rare. Dr Smith records the first one as having been taken May 7, 1874, and it has been observed only three or four times since. The recent specimens have been caught in traps at Quisset Harbor, in the latter part of September or early in October;

these specimens weighing each 4½ or 5 pounds. The largest drum recorded was taken at St Augustine Fla. and weighed 146 pounds. The large fish are not much valued for food, but small ones are said to be excellent.

Genus APLODINOTUS Rafinesque

Body oblong, the snout blunt, the back elevated and compressed; mouth rather small, low, horizontal, the lower jaw included; teeth in villiform bands, the outer above scarcely enlarged; no barbels; pseudobranchiae rather small; gill rakers short and blunt; lower pharyngeals very large, fully united, with coarse, blunt, paved teeth, as in Pogonias; preopercle slightly serrate; dorsal spines strong and high, with a close fitting scaly sheath at base, the two dorsals somewhat connected; second anal spine very strong; caudal double truncate; air bladder very large, simple, with no appendages; pyloric caeca seven; vertebrae 10+14 = 24. Fresh waters of the United States; large, coarse fishes, feeding chiefly on crustacea and mollusks. The genus is apparently allied to Pogonias, and both may be descended from allies of Roncador, which is intermediate between them and Sciaena.

287 Aplodinotus grunniens Rafinesque

Fresh-water Drum; White Perch

Aplodinotus grunniens RAFINESQUE, Jour. de Phys. Paris, 88, 1819, Ohio River; BEAN, Fishes Penna. 135, pl. 35, fig. 73, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1484, 1898, pl. CCXXVI, fig. 574, 1900.

Sciaena oscula LE SUEUR, Jour. Ac. Nat. Sci. Phila. 252, pl. 13, 1822, Lake Ontario.

Amblodon neglectus GIRARD, U. S. Mex. Bd. Surv. Fish. 12, pl. 5, figs. 6-10, 1859.

Amblodon grunniens GIRARD, U. S. Pac. R. R. Surv. Fish. 96, pl. 23, 1858.

Haploidonotus grunniens GILL, Proc. Ac. Nat. Sci. Phila. 104, 1861; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 567, 1883.

Corvina oscula DE KAY, N. Y. Fauna, Fishes, 73, pl. 21, fig. 63, 1842, Lakes Erie & Ontario; GÜNTHER, Cat. Fish. Brit. Mus. II, 297, 1860.

The shape of the fresh-water drum is similar to that of the salt-water species, the body being moderately elongate, its greatest hight one third of its length without the caudal; the sides are moderately compressed and the back very much so.

The least depth of the tail is less than one third of the depth of the body. The head is rather short, its length contained three and two thirds times in the total without caudal. The eye is about four fifths as long as the snout and one sixth length of head. Snout obtuse. The maxilla reaches to below the middle of the eye; the lower jaw is shorter than the upper. The pectoral is nearly as long as the head and reaches to below the beginning of the soft dorsal. The ventral is about two thirds length of head. The third dorsal spine is the longest, nearly one half as long as the head. The second anal spine is much the longer and stouter, its length two fifths that of head. The rays of the soft dorsal are longest near the end of the fin. The scales are very irregularly placed, about 55 in the lateral line.

D. IX, I, 30–31; A. II, 7.

The color is grayish, darker on the back; lower parts silvery. Young specimens have dark spots along the rows of scales, forming oblique lines.

The fresh-water drum has received a great number of common names. In the Ohio valley and South it is known as the white perch; in the Great Lake region it is called sheepshead or fresh-water drum on account of its resemblance to the salt-water drum. At Buffalo and Barcelona, New York, it is known as sheepshead. The name crocus, used on lakes of northern Indiana is a corruption of croaker, a name of a marine fish of the same family. In the southern states the name drum is generally applied to the species, and in addition the terms thunder pumper, gaspergou and jewel head are used. Gaspergou is a term used in Arkansas, Louisiana and Texas. The names drum, croaker and thunder pumper have reference to certain sounds produced by the fish either by means of its air bladder or by grinding together the large molarlike teeth in the pharynx. The name jewel head probably refers to the otoliths or ear-bones, frequently called lucky stones, which are found in the skull of this species. In Texas, adjacent to Mexican territory, occurs the name gaspagie, a variation of the name gaspergou.

The fresh-water drum is widely distributed; it occurs in Lake

Champlain and the entire Great lakes region, the Ohio and Mississippi valleys southward to Texas. The U. S. Fish Commission obtained a specimen at Point Breeze N. Y. on Lake Ontario. De Kay reported it as very common in Lake Erie and called sheepshead at Buffalo. At the time of his writing the fish was scarcely ever eaten. It is found principally in large streams and lakes and rarely enters creeks and small rivers. In western Texas the species is rare. In the wilds of Texas, New Mexico and northern Mexico Mr Turpe has found this fish in clear limestone streams emptying into the Rio Grande.

This species is usually found on the bottom, where it feeds chiefly on crustaceans and mollusks and sometimes small fishes. It is specially fond of crawfish and small shells such as Cyclas and Paludina. Mr Turpe mentions water plants as forming part of its food and states that it will take a hook baited with worms or small minnows.

The fresh-water drum grows to a length of 4 feet and a weight of 60 pounds, but the average market specimens rarely exceed 2 feet in length and in many parts of the West much smaller ones are preferred. Nothing is recorded about the breeding habits of this species, and as to its edible qualities there is the greatest difference of opinion. Some writers claim that its flesh is tough and coarse with a disagreeable odor, specially in the Great lakes. Individuals from the Ohio river and from more southern streams are fairly good food fish, while in Texas Mr Turpe considers it one of the most excellent of the fresh-water fishes, comparing favorably with black bass. Mr Robert Ridgway of the National Museum at Washington, pronounces the species from the Wabash river in Indiana, a fine table fish though, he says, other people there consider it inferior. Richardson described what is supposed to be a deformed specimen of this drum under the name of malashegany, which he had from Lake Huron. He described it as a firm, white, well-tasting fish, but never fat and requiring much boiling.

Suborder PHARYNGOGNATHI

Labroid Fishes

Family LABRIDAE

Wrasse Fishes

Genus TAUTOGOLABRUS Günther

Body oblong, not elevated, comparatively slender and compressed; head moderate, more or less pointed, but the jaws not notably produced; teeth in the jaws in several series, the outermost very strong; the teeth unequal, conical and pointed; no posterior canines. Cheeks with small scales; opercles with large ones; interopercles naked; preopercle with the vertical limb finely serrated. Branchiostegals five. Gill membranes considerably united, free from the isthmus; gill rakers short. Scales moderate, 35 to 50 in the lateral line; lateral line continuous, abruptly bent opposite posterior part of second dorsal; dorsal long and low, the spinous portion much longer than the soft, of 18 or 19 low, subequal, rather strong spines; soft dorsal slightly elevated; anal fin similar to soft dorsal, with three strong graduated spines; caudal truncate; pectorals short, the ventrals inserted behind their axils. Species two, both American. This genus is very close to the European genus Ctenolabrus, differing in the less perfect squamation of the head and in the greater number of dorsal spines and vertebrae.

288 **Tautogolabrus adspersus** (Walbaum)

Bergall; Cunner; Chogset; Nipper

Labrus adspersus WALBAUM, Art. Gen. Pisc. 254, 1792.

Tautoga Caerulea MITCHILL, Rep. Fish. N. Y. 24, 1814, New York.

Labrus chogset MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 402, pl. 3, fig. 2, 1815, New York.

Labrus chogset fulva MITCHILL, l. c. 403, 1815, New York.

Ctenolabrus uninotatus CUVIER & VALENCIENNES, Hist. Nat. Poiss. XIII, 239, 1839, New York, young; DE KAY, N. Y. Fauna, Fishes, 174, pl. 29, fig. 90, 1842; GÜNTHER, Cat. Fish. Brit. Mus. IV, 90, 1862.

Ctenolabrus burgall GÜNTHER, l. c. 90, 1862, Canada.

Ctenolabrus chogset CUVIER & VALENCIENNES, Hist. Nat. Poiss. XIII, 237, 1839.

Ctenolabrus ceruleus DE KAY, N. Y. Fauna, Fishes, 172, pl. 29, fig. 93, 1842.

Ctenolabrus adspersus JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 599, 1883; BEAN, 19th Rep. Comm. Fish. N. Y. 251, pl. IV, fig. 6, 1890.

Tautogolabrus adspersus Goode & Bean, Bull. Essex Inst. XI, 14, 1879; Bean, Proc. U. S. Nat. Mus. 87, 1880; Bull. Am. Mus. Nat. Hist. IX, 368, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 102, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1577, 1898, pl. CCXXXVI, fig. 595, 1900; Bean, 52d Ann. Rep. N. Y. State Mus. 107, 1900; Sherwood & Edwards, Bull. U. S. F. C. 1901, 30, 1901.

Body fusiform, stout, its greatest depth nearly one third of total length without caudal, the profile much less convex than in the tautog; least depth of caudal peduncle one half of greatest depth of body. Head one third of total length without caudal, the snout pointed, and forming one third of the length of head; eye placed high, its diameter one fifth length of head; preorbital bone not equal in width to the eye; jaws equal, with thick lips; mouth moderate, the maxillary nearly reaching to vertical from front of eye; five canines in front of upper jaw, about four in lower, the teeth on sides of jaw largest in front; bands of small concave teeth behind canines; gill rakers very short, about 6+11 on first arch; scales rather small; top of head, preorbital, maxillary, mandible, interopercle, and posterior edge of preopercle and opercle naked; preopercle with about five rows of small scales; opercle with four or five rows of larger ones; fins naked. Base of spinous dorsal two and one half times as long as that of soft dorsal; the spines gradually increasing in length up to the seventh, from which they are about equal, the seventh about three eighths as long as the head, the first only one sixth as long as the head. Soft dorsal a little higher than spinous, the longest ray one half as long as the head. Caudal rounded, its middle rays about one half as long as the head. Anal under the second half of the dorsal, its base as long as the head without the snout; the spines stout and sharp, the first equal to the eye in length, the second and third nearly equal and a little more than one third length of head; the fourth and fifth soft rays equal, longest, one half as long as the head. Pectoral broad, short, one half as long as the head. Ventral slightly longer than pectoral, not reaching to vent.

D. XVIII, 9 or 10; A. III, 9; scales 6–47–13; vertebrae 17+19.

Color bluish or brownish, usually with a brassy luster on sides; head and back sometimes spotted with brassy; young with darker blotches and markings, and often with a black blotch near the middle of the dorsal fin. Some individuals are yellowish and the young are often green.

The cunner is known also as chogset and bergall (this changed to bengal in Great Egg Harbor bay, N. J.). Mitchill gives the name of bluefish as in use in New York in 1815; perch, sea perch and blue perch are New England names given for this fish. Names used with reference to its bait-stealing propensities are: nipper and bait-stealer.

The cunner is common from Labrador to at least as far south as New Jersey.

The bergall is found in Gravesend bay throughout the year. In 1898, the writer found it in Peconic bay and the adjacent Scallop pond; south side of Great South bay opposite Patchogue; Fire Island inlet; Blue Point cove; and Duncan's creek. In 1899, young examples were taken at Water Island ocean beach, June 6. In 1901, young of a yellow color and only 1⅜ inches long were seined in a creek near Fire Island inlet, August 15. Half grown and adults were caught at a wreck on Tobey's Flat, August 14, and at Smith's Point, August 23.

At Woods Hole Mass. the cunner is very abundant and remains during the entire year. Thousands perish from cold every winter. The fish spawns in June. The egg is about $\frac{1}{16}$ inch in diameter, buoyant, and has been hatched in the tidal cod-jar in five days in water of a mean temperature of 56° F. By August 1 the young an inch long are observed. Outside of Gayhead and Cuttyhunk the fish reaches a weight of 2½ pounds, but the usual weight is from ¼ to ½ pound. In February 1901, thousands of cunners were killed by extreme cold at Woods Hole.

The cunner endures captivity very well, individuals having been kept three years or longer. The species is usually associated with the tautog or blackfish; in many places it proves a great annoyance to fishermen. In some parts of New England the fish is highly esteemed, but farther south it is not in high

repute, the hard scales and stiff, sharp spines making it inconvenient to prepare for cooking.

Dr Mitchill describes a yellow variety of the cunner, and De Kay has considered the young, which has a black spot on the anterior portion of the dorsal fin, as a distinct species, named by him the spotted bergall.

The young vary greatly in color. We have seen some dull brown, others that were yellowish, and still others of a bright green. Dusky bands are characteristic, also, of the young stages. Examples were taken at Blue Point cove and at Fire Island. The cunner is a permanent resident, and does not retreat into deep water except in very cold weather. Its spawning takes place in June and July. The species is fished for with the hook, and is taken in nets, which are baited and set among the rocks. The catch of the Irish cunner boats of Boston has been estimated at about 300,000 pounds annually.

Genus TAUTOGA Mitchill

Body long, not elevated nor greatly compressed. Head large, nearly as deep as long, with a convex profile. Mouth rather small. Teeth very strong, conical, in two series; the outer somewhat incisorlike; the two anterior teeth in each jaw strong; the posterior teeth small, without canines. Eye small, high up. Cheeks with small scales; interopercle naked; opercles naked, except above; scales on body rather small, in about 60 transverse series, those on ventral region reduced in size; lateral line continuous, abruptly decurved opposite the end of the soft dorsal. Dorsal fin long, low, continuous, the spinous part much the longer, with about 16 low, strong, subequal spines, each with a small cutaneous appendage at tip; soft dorsal higher than spinous; anal similar to soft dorsal, with three stout, graduated spines; pectorals broad and rather short; caudal short, truncate, with rounded angles; the soft parts of the vertical fins with the membranes somewhat scaly; ventrals conspicuously behind pectorals. Branchiostegals five. Gill rakers very short and feeble; gill membranes somewhat connected, free from the isthmus. Vertebrae 16+18=34. This genus contains a single species, a large Labroid, abundant on the Atlantic coast of the United States.

289 Tautoga onitis (Linnaeus)

Blackfish; Tautog

Labrus onitis Linnaeus, Syst. Nat. ed. X, 286. 1758; ed. XII, 478, 1766.
Tautoga niger Mitchill, Rep. Fish. N. Y. 23, 1814, New York.
Labrus tautoga Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 399, 1815, Long Island.
Tautoga americana De Kay, N. Y. Fauna, Fishes. 175, pl. 14, fig. 39. 1842; Storer, Hist. Fish. Mass. 110, pl. XX, fig. 2, 1867.
Tautoga onitis Günther, Cat. Fish. Brit. Mus. IV, 88, 1862; Goode & Bean, Bull. Essex Inst. XI, 14, 1879; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 600, 1883; Bean, Bull. U. S. F. C. VII, 137, pl. III, fig. 3, 1888; 19th Rep. Comm. Fish. N. Y. 252, pl. V, fig. 7, 1890; Bull. Am. Mus. Nat. Hist. IX, 368, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 102, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1578, 1898, pl. CCXXXVII, fig. 596, 1900; Bean, 52d Ann. Rep. N. Y. State Mus. 107, 1900; Sherwood & Edwards, Bull. U. S. F. C. 1901, 30, 1901.

Body deep, moderately compressed, the outline of head and back convex, the greatest depth three eighths to one third of total length without caudal, the least depth of caudal peduncle equal to postorbital part of head. Head short, blunt, its length contained three and one fourth to three and one half times in total without caudal; profile of snout very steep; preorbital very wide, wider than the eye; mouth small, with very thick lips, the maxillary reaching the vertical from anterior or posterior nostril; eye one fifth as long as the head; snout one third as long as the head; jaws nearly equal in front, with two or three large canines and smaller ones on the side, gradually diminishing in size backwards. A patch of small scales behind eye extending downward to middle of cheek where there are five or six series; a small patch of scales at upper edge of opercle; head elsewhere naked. About 3+6 very short and blunt gill rakers on first arch. Spinous dorsal composed of stout, sharp spines, the connecting membrane between them projecting beyond them; the first spine as long as the eye; the spines gradually increasing in length to the 11th which is one third as long as the head and twice as long as the first; the remaining spines are about equal to the 11th; the base of soft dorsal is one half as long as the head; the longest ray is nearly twice as long as the last ray and more than one half as long as the head. Caudal convex, the middle rays about one half as long as the

head. Anal base coterminous with the dorsal base, two thirds as long as the head, the spines rather long, stout, and graduated, the first a little longer than the eye, the third twice as long as the eye; the third and fourth rays longest, as long as postorbital part of head. Pectoral large, as long as the head without the snout, reaching to below the 10th spine of the dorsal. Ventral one half as long as the head, reaching to below the 12th spine of the dorsal. D. XVI to XVII, 10; A. III, 8; V. I, 5; P. I, 15. Scales 14–60 to 65–29.

Color blackish, greenish, frequently pale bluish or bluish black with metallic reflections. Often with irregular bands of a deeper hue. Lips, lower jaws and abdomen lighter, sometimes pale, sprinkled with black points, and sometimes of the same color as the rest of the body. Eye greenish.

This is better known in New York as the blackfish; farther south it is styled chub or salt-water chub, Moll, Will George and oyster fish. Mitchill gives the name tautog as of Mohegan origin. He publishes for the species the names toad, blackfish and runner. The Mohegan name tautog, according to De Kay, is said to mean black. The fish is found from Nova Scotia to Virginia. It occurs in all parts of Great South bay visited by us. Some of the localities at which it was taken are the following: Blue Point cove and Lifesaving station, Great River beach and Fire Island. The name used at Patchogue is blackfish. We saw a few tautog among the fishes caught in a trap at Islip, October 1, 1890. In 1898 specimens were obtained in Peconic bay, at Blue Point cove, Islip, Nichols's Point and Fire Island inlet; young individuals were taken July 29, August 25, September 1 and 16. Following is a list of localities in which the tautog was sparingly taken in Great South bay in 1901:

Clam Pond cove.....July 19
Fire Island inlet.....August 15
Cherry Grove.....August 17
Smith's Point.....August 23
Mouth Swan river.....September 5
Off Widow's creek (young).....September 28
Off Swan river (young).....October 7 and 11

Dr Mitchill gives a most entertaining account of the habits and mode of capture of this well known species. At the time of his writing, in 1814, the price varied from eight to 12 cents a pound.

It has been known to reach a length of 3 feet and a weight of 21½ pounds. Individuals of 12 to 14 pounds have occasionally been taken off Cape Ann. The fishing season begins in April and may last till winter. Examples are sometimes speared in the winter months in New England rivers. The tautog is not migratory, but hibernates in cold weather, going into the mud in November or December. It is sometimes destroyed by freezing; such accidents have occurred in ponds on Martha's Vineyard and elsewhere.

The spawning season begins late in April. The eggs are deposited in depths of 6 to 8 feet or more among the rocks. In the fish cultural operations at Woods Hole Mass. it was found that the egg is buoyant and only $\frac{1}{25}$ inch in diameter; in the automatic tidal box they hatched in about five days with the water temperature at 69° F., and in two or three days with the temperature at 71°.

There is great diversity in the colors of the young, just as in the case of the young cunners. Some are bright green, others brown or red and some are mottled with brown, red and green, intermingled with pale areas. The food of the tautog consists of mollusks and crustaceans; crabs, and specially fiddlers, barnacles, clams and lobsters are among the favorite articles of food. The annelids, known as sandworms, are also very attractive to it.

The tautog is an excellent food fish and one of the commonest of our market species. It is a permanent resident in the bays and is hardy in captivity. Individuals have been kept longer than three years and some of them have grown remarkably. Their food includes chopped hard clam, live killifish, shrimps, and fiddler crabs, of which latter they are extremely fond. Spawning takes place regularly in the tanks in spring, but, as the eggs are very small and buoyant, they must invariably be lost at the overflow. As the newly hatched embryos are only $\frac{1}{12}$ inch long they too would flow out unseen if any were left for development.

Group ZEOIDEA

Family ZEIDAE

John Dories

Genus ZENOPSIS Gill

Body ovate, much compressed, without scales, and without warts or humps in the adult. Head deeper than long, its anterior profile steep. Mouth rather large, upper jaw protractile; teeth small on jaws and vomer, none on the palatines. Various bones of the head and shoulder girdle armed with spines. Series of bony plates along the sides of the belly and the bases of both dorsal and anal, each plate armed with a strong spine. Eye large, placed high. Gill rakers short. Dorsal spines very strong, usually 10 in number, some of them filamentous; anal spines three; ventral fins long, the rays I, six or I, seven. Caudal peduncle slender, the fin not forked. Three species known, differing from the European genus Zeus mainly in the presence of three anal spines instead of four, and in the greater development of the spinous armature. Pelagic.

290 **Zenopsis ocellatus** (Storer)

John Dory

Zeus ocellatus STORER, Proc. Bost. Soc. Nat. Hist. VI, 385, 1858, Provincetown Mass.; PUTNAM in STORER, Hist. Fish. Mass. 279, 1867.

Zenopsis ocellatus GILL, Proc. Ac. Nat. Sci. Phila. VI, 126, 1862; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 456, 1883; GOODE & BEAN, Oceanic Ichth. 224, with plate, 1896; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1660, 1898, pl. CCXLVI, fig. 618, 1900.

Body short, deep, compressed, its greatest depth one half of total length including caudal; the caudal peduncle short and very slender, its least depth scarcely more than one half diameter of eye. Head subquadrangular, large, the mouth large and very oblique, the maxillary one sixth of total length without caudal, its width posteriorly nearly one half its length. A slight concavity over the eyes. Eye two ninths as long as the head and placed high. Snout two fifths as long as head. Top of head with roughish ridges, but without spines; a spine at the base of each dentary bone; a supplemental maxillary bone; teeth nearly obsolete. Gill rakers short. Skin naked except for the

bony bucklers which are armed each with a central spine hooked backward and marked with radiating ridges; seven bucklers along the base of the dorsal, the fifth and sixth largest, these located under the fifth to the 19th dorsal ray; two on the median line in front of the ventrals, the second larger, as long as the eye; about eight plates between ventrals and anal origin, and five along base of anal. Dorsal spines stout and long, the first four or five filamentous, the second longest, equal to total length without the head and the caudal fin; the base of the fin five sixths as long as the head. Soft dorsal base a little longer, as long as the head; the rays short, the longest, near the end of the fin, equal to diameter of eye. Caudal fin short, rounded, the middle rays as long as the postorbital part of head. Pectoral short, about as long as snout. Ventrals long, nearly as long as the head, and almost reaching to the anal origin. Anal long, one half of total length without caudal, the spinous and soft portions scarcely connected; the first spine longest, one and one half times as long as the third, and one fifth as long as the head; the longest anal ray nearly one third as long as the head. D. X, 24; A. III, 24; V. I, 5; P. 12.

Color silvery, nearly plain; a black lateral ocellated spot in life, disappearing in spirits.

Of this pelagic species only one specimen is known; this was taken off Provincetown Mass. and presented to the museum of the Boston Society of Natural History by Capt. N. E. Atwood.

Suborder SQUAMIPINNES

Scaly Fins

Family EPHIPPIDAE

Spadefishes

Genus CHAETODIPTERUS Lacépède

Body much elevated and compressed, its outline nearly orbicular, the anterior profile nearly vertical. Scales small, 55 to 70 in the course of the lateral line. Jaws about equal; no teeth on vomer or palatines; teeth on jaws slender, somewhat movable; preopercle finely serrulate. Branchiostegals six. Dorsal fins two, somewhat connected, the first of usually nine spines,

the third of which is elongate; anal spines three, small, the second the longest; ventral with a large accessory scale. Pyloric caeca four to six. American; distinguished from the Asiatic genus Ephippus by the very much smaller scales.

291 Chaetodipterus faber (Broussonet)

Spadefish; Triple tail; Angelfish; Moonfish

Chaetodon faber Broussonet, Ichth. Decas. 1, V, pl. 4, 1782, Jamaica; Carolina.

Chaetodon oviformis Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 247, pl. V, fig. 4, 1815, New York; Am. Month. Mag. II, 247, February, 1818.

Ephippus gigas Cuvier, Règne Anim. ed. 2, vol. 2, 191, 1829, America; De Kay, N. Y. Fauna, Fishes, 99, pl. 23, fig. 71, 1842, New York; Holbrook, Ichth. S. C. ed. 1, 105, pl. 15, fig. 2, 1856; Günther, Cat. Fish. Brit. Mus. II, 61, 1860.

Ephippus faber De Kay, N. Y. Fauna, Fishes, 97, pl. 23, fig. 68; Holbrook, Ichth. S. C. ed. 1, 108, pl. 15, fig. 1, 1856; Günther, Cat. Fish. Brit. Mus. II, 61, 1860.

Chaetodipterus faber Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 613, 1883; Bean, 19th Rep. Comm. Fish. N. Y. 253, pl. VI, fig. 8, 1890; H. M. Smith, Bull. U. S. F. C. 1897, 102, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1668, pl. CCXLVII, fig. 619, 1900.

Body oblong-ovate, its greatest depth equal to the distance from the eye to the end of the dorsal base or anal base; least depth of caudal peduncle one half length of head. Head short, two sevenths of total length without caudal; snout two fifths as long as the head; preorbital deep, equal to diameter of eye, which is three tenths as long as the head; mouth moderate, nearly horizontal, the maxilla reaching to below front of eye; chin with a row of pores; dorsal and ventral outlines similar, greatly convex. First dorsal spine minute; second very short, one half as long as the eye; third spine longest, as long as the head without the snout; fourth spine one third as long as the head; the remaining spines rapidly diminishing in size to the last which is one third as long as the eye. The soft dorsal is separated from the spinous by a deep notch; the anterior part of the fin is greatly elevated, the longest ray being three sevenths of total length without caudal; the fin is falcate, the last rays being short. Caudal crescentic with the outer rays produced, and about as long as the head. Anal similar in shape

to the soft dorsal; the first spine one half as long as the eye, the second as long as the eye, and the third three fourths as long as the second; the longest rays equal one half of greatest depth of body. Pectoral short, rounded, one half as long as the head. Ventral much longer, as long as the head, reaching beyond the vent.

D. VIII, I, 20 to 22; A. III, 18; V. I, 5; P. I, 16; lateral line 60 to 65; pyloric caeca 4 to 6; vertebrae 9 or 10–14.

Grayish; a dusky band across the eye to the throat; a second similar band, broader, beginning in front of the dorsal and extending across the base of the pectoral to the belly; a third band, narrower, extending to the middle of the sides from the base of the fourth and fifth dorsal spines; a fourth broader band from the last dorsal spines to anal spines, the remaining bands alternately short and long; all of these bands growing obscure and disappearing with age; ventrals black.

The moonfish is the sheepshead chaetodon of Mitchill, and the banded ephippus of De Kay. Dr Mitchill records it as taken at the east end of Long Island, July 27, 1815. De Kay, in his *New York Fauna*, has the following concerning the species: "About twenty years since, they were caught here in seines in great numbers and exposed in the markets for sale. Some of them were 18 inches long. Those described by Mitchill were captured in 1815 and 1817. The popular names of three-tailed sheepshead and three-tailed porgee were given them by the fishermen in allusion to their prolonged dorsal and anal fins. . . Schoepff states that it is called angelfish in South Carolina."

The species is called spadefish in the states bordering the Gulf of Mexico.

The moonfish has occasionally been taken as far north as Cape Cod. Dr Smith records it as a very rare straggler in Vineyard Sound, Mass. A specimen was obtained in 1889, and three have been observed since. All were taken in traps at Menemsha in August and September. The fish were uniform in size and about 16 to 18 inches long. The species reaches a length of 2 to 3 feet. Southward it is recorded from as far as Guatemala.

It occurs in the West Indies. In Chesapeake bay it is moderately common.

As a food fish this species is highly prized by those who are familiar with its qualities.

Family CHAETODONTIDAE

Butterfly Fishes

Genus CHAETODON (Artedi) Linnaeus

Body short, deep, very strongly compressed, specially above and behind; head small, compressed, almost everywhere scaly; mouth very small, terminal, the jaws provided with long, slender, flexible, bristlelike teeth; vomer sometimes with teeth; preoperculum entire or nearly so, without spine. Dorsal fin single, continuous, not notched, the spinous part longer than the soft part, of about 13 spines, the spines not graduated, some of the middle ones being longer than the last; last rays of soft dorsal usually rapidly shortened, some of them occasionally filamentous (in East Indian species); caudal peduncle short, the caudal fin fan-shaped; anal similar to soft dorsal, preceded by three or four strong spines. Body covered with rather large ctenoid scales, somewhat irregular in their arrangement; the lateral line curved, high, parallel with the back. Gill openings rather narrow, the membranes narrowly joined to the isthmus; branchiostegals six. A very large genus of singular and beautiful fishes abounding in the tropical seas, specially about volcanic rocks and coral reefs; most of them have the body crossed by transverse black bars. They are all very active, feeding on small animals.

Subgenus CHAETODONTOPS

292 Chaetodon ocellatus Bloch

Parche

Chaetodon ocellatus BLOCH, Ichth. III, 105, pl. 211, fig. 2, 1787; EIGENMANN & HORNING, Ann. N. Y. Ac. Sci. IV, 7, 1887; BEAN, Bull. Am. Mus. Nat. Hist. IX, 368, 1897; H. M. SMITH, Bull. U. S. F. C. 1897, 102, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1674, 1898, pl. CCXLIX, fig. 621, 1900; H. M. SMITH, Bull. U. S. F. C. 1901, 33, 1901.

Chaetodon bimaculatus BLOCH, Ichth. pl. 219, fig. 1, 1790; CUVIER & VALENCIENNES, Hist. Nat. Poiss. VII, 67, 1831; GÜNTHER, Cat. Fish. Brit. Mus. II, 9, 1860; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 940, 1883.

Sarothrodus maculocinctus GILL, Proc. Ac. Nat. Sci. Phila. 99. 1861. Newport R. I.; young.

Chaetodon maculocinctus JORDAN & GILBERT, Bull. 16. U. S. Nat. Mus. 616. 1883; BEAN, Bull. U. S. F. C. VII, 138, pl. I, fig. 4, 1888.

Body subovate, strongly compressed; greatest depth three fifths to two thirds of total length without caudal; least depth of caudal peduncle about one third length of head. Head two fifths of total without caudal; the upper profile concave except for a slight protuberance over eyes; snout equals five sixths diameter of eye, which is one third as long as the head; the maxilla reaches to below the anterior nostril, its length equal to length of snout; lower jaw somewhat produced; suborbital bone one half as wide as the eye. First dorsal spine one fourth as long as the head; second spine about one half as long as head; third and fourth spines longest, as long as the head without the snout; last spine two fifths as long as head; longest soft ray one half as long as the head. Anal fin under the posterior half of the dorsal; the first spine as long as the snout; the second longest, nearly one half as long as the head; the third nearly as long as the second; the longest ray as long as the second spine; the base of the fin equals one third of total length without caudal. Caudal rounded, the middle rays one half as long as the head. Pectoral reaching to below the 10th spine of the dorsal, as long as the head without the snout. Ventral reaching to the second anal spine, four fifths as long as the head.

D. XII or XIII, 18 to 20; A. III, 16 to 18; V. I, 5. Scales 8–45 to 50–20.

Color golden gray, sometimes yellow or orange; a large, oblong, dark blotch on base of soft dorsal extended downward by a black band crossing the body and continuing faintly upon the base of the anal; a dark band from the origin of the dorsal through the eye and extending downward across the cheek. The bands are nowhere more than one half as wide as the eye.

The parche belongs to the West Indian fauna; it is common at Havana, and the young follow the Gulf Stream northward in summer to New Jersey, Long Island, Rhode Island, and Cape Cod. In the vicinity of Woods Hole Mass. according to Dr Smith,

it must now be regarded as a common species, for, in 1900, the number of specimens taken at Katama bay was 123; these were observed on 13 different occasions between August 15 and October 26; on September 8 the number taken was 26 and 21 were seined on October 3. Up to 1897 only a few specimens had been secured annually in October and November—not more than five in any one season.

A single individual, 1¼ inches long, was taken in the seine at Beesley's Point N. J. September 2.

The general color of the sides was yellow, more persistent in alcohol on the ventral surface and caudal peduncle than elsewhere.

D. XIII, 20; A. III, 18; lateral line, 45; third and fourth dorsal spines equal, and as long as the head without the snout.

The parche is very rare in Gravesend bay. Two small individuals were taken by Mr De Nyse in October 1898. Mr De Nyse informs me that the roundish black spot in the soft dorsal remains fixed under all conditions, while the band extending from it to the anal fin sometimes disappears. The whole body of the fish at times appears to have an orange tinge, but at other times it is gray.

An individual about 2 inches long was obtained from a fish pound near Clam Pond cove, Oct. 17, 1898. This species is conspicuously beautiful on account of the orange color of its fins contrasting sharply with the dark bands on the head and body.

Family TEUTHIDIDAE

Surgeons

Genus TEUTHIS Linnaeus

This genus includes those Teuthididae which have the tail armed with a sharp, antrorse, lancetlike, movable spine; strong, fixed, incisor teeth; ventral rays I, five, and usually nine spines in the dorsal fin. The numerous species are found in all tropical seas, herbivorous fishes living about coral reefs. The adult is protected by the murderous caudal spine, which grows larger with age.

293 Teuthis hepatus Linnaeus

Surgeons; Doctor Fish; Tang

Teuthis hepatus Linnaeus, Syst. Nat. ed. XII, 507, 1766, Carolina; Meek & Hoffman, Proc. Ac. Nat. Sci. Phila. 229, 1884; Bean, Bull. Am. Mus. Nat. Hist. IX, 368, 1897; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1691, 1898.

Acanthurus phlebotomus Cuvier & Valenciennes, Hist. Nat. Poiss. X, 176, 1835, New York, etc.; De Kay, N. Y. Fauna, Fishes, 139, pl. 73, fig. 234, 1842.

Acanthurus chirurgus Cuvier & Valenciennes, Hist. Nat. Poiss. X, 168, 1835; Günther, Cat. Fish. Brit. Mus. 329, 1861; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 617, 1883.

Acanthurus nigricans Jordan & Gilbert, l. c. 941, 1883.

Body ovate, its greatest depth one half of total length without caudal; anterior profile moderately convex, forming an angle of 45° with axis of body. Caudal lunate, its inner rays about two thirds length of outer rays; caudal lobes subequal, the upper never filamentous. Head rather short, two sevenths of total length without caudal. D. IX, 26; A. III, 24.

Color dark olive brown, more or less distinctly greenish; middle of sides paler; sides with about 12 distinct blackish vertical bars, rather narrower than the interspaces, most distinct over front of anal; a brownish stripe along base of dorsal; spinous dorsal with alternate stripes running upward and backward, of dark blue and bronze olive, the two colors of about equal width; soft dorsal with a bluish streak on the anterior side of each ray, and a bronze stripe behind it; fins very dark, often almost black.

The surgeon is common in the West Indies and from Florida to Bahia and northward in summer to Cape Cod.

A young individual, about 3 inches long, was caught in Mr John B. De Nyse's pound, Gravesend bay, Oct. 22, 1897. The species had not been certainly known before to occur north of Charleston S. C. De Kay described and figured it as a New York species solely on the authority of Cuvier and Valenciennes. Dr Smith records the capture of a few specimens in the vicinity of Woods Hole Mass. during the summer of 1900. It was last observed on October 3 when one example was taken.

Group PLECTOGNATHI

Suborder SCLERODERMI

Family BALISTIDAE

Triggerfishes

Genus BALISTES (Artedi) Linnaeus

Body compressed, covered with thick, rough scales or plates of moderate size, 50 to 75 in a lengthwise series; a naked groove before eye below nostrils; lateral line more or less developed, very slender, undulate, conspicuous only when the scales are dry, extending on the cheeks. Pelvic flap large, movable, supported by a series of slender, pungent spines. Caudal peduncle compressed, its scales unarmed, without spines or differentiated tubercles similar to those on rest of body. Gill opening with enlarged bony scutes behind it; cheeks entirely scaly, without naked patches or grooves. Both jaws with irregular, incisor-like teeth, usually four on each side in each jaw. First dorsal of three spines, the anterior of which is much the largest, the second acting as a trigger, locking the first when erected; the third nearly as large as second and remote from it; second dorsal and anal long, similar to each other, in the adult always falcate or filamentous in front; caudal fin rounded, with the outer rays much produced in the adult; branchiostegals six; vertebrae 7+10. Species rather few, chiefly American; some of them straying to the Old World.

Subgenus CAPRISCUS Rafinesque

294 Balistes carolinensis Gmelin

Leather Jacket; Turbot; Triggerfish

Balistes carolinensis GMELIN, Syst. Nat. I, 1468, 1788, Carolina; BEAN, Bull. Am. Mus. Nat. Hist. IX, 368, 1897; H. M. SMITH, Bull. U. S. F. C. 1897, 104, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1701, 1898, pl. CCLVIII, fig. 632, 1900.

Balistes capriscus GMELIN, Syst. Nat. I, 1471, 1788, Indian & American Oceans; GÜNTHER, Cat. Fish. Brit. Mus. VIII, 217, 1870; GOODE & BEAN, Bull. Essex Inst. XI, 3, 1879; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 855, 1883.

Balistes fuliginosus DE KAY, N. Y. Fauna, Fishes, 339, pl. 57, fig. 188, 1842, New York.

Body oblong, compressed, its greatest depth one half of total length to end of middle caudal rays; least depth of caudal peduncle one third length of head. Head nearly one third of total length without caudal; eye small, placed high, one fourth as long as the snout, and one fifth as long as the head; mouth small, terminal, the maxillary as long as the eye. Dorsal origin slightly behind vertical of hind margin of orbit; base of spinous dorsal one fourth of total length without caudal; first spine longest, one half as long as the head; second spine slender, one third as long as the head; third spine stouter than second, one fifth as long as the head. An interspace between spinous and soft dorsal. Soft dorsal base slightly longer than the head; the third and fourth rays longest, as long as the snout; the last ray shorter than the eye. Middle caudal rays one half as long as the head; external rays five sixths as long as the head. Anal opposite and similar to soft dorsal, its base as long as the head, its longest ray one fifth of total length without caudal. Pectoral short, one half as long as the head, reaching to below third spine of dorsal. Ventral flap large, supported by several slender pungent spines. D. III, 27; A. 25; scales 55 to 63 (58 in specimen examined), about 38 in a transverse series from vent upward and forward. Lateral line very inconspicuous, extending from the eye backward to below the third dorsal spine, where it descends to a point nearly over the sixth or seventh ray of the anal; here it turns to form a V-shaped figure ascending to the median line and along the middle of the caudal peduncle to the base of the caudal fin; a branch from behind eye extends obliquely downward and forward to the breast below pectorals; the lateral lines of the two sides are connected by a cross branch at the nape.

Color in life olive gray; a more or less distinct darker crossbar under front of second dorsal and one under last ray; some small violet spots on upper part of back; usually a ring of blue spots, alternating with olive green streaks, about eye; violaceous marks on sides of snout; first dorsal spotted and clouded with bluish; second dorsal pale yellowish with clear sky-blue

spots separated by olive green reticulations, the spots arranged in rows; blue markings all fading in alcohol, leaving the olivaceous streaks; base of dorsal with three or four dark diffuse shades in the young; base of pectoral bluish, with olive spots; anal colored like soft dorsal; pectoral greenish.

The triggerfish inhabits the tropical parts of the Atlantic occasionally following the Gulf Stream northward as far as Cape Cod. In the Colonial Museum at Halifax is a specimen said to have been taken on the coast of Nova Scotia. At Woods Hole Mass. it is very rare and does not occur every year; the young have not been observed there.

The species is uncommon in Gravesend bay, Long Island, but is seen occasionally in summer in the bays opening into the Atlantic. De Kay described a specimen measuring 12½ inches. In the year 1820, a specimen was obtained for him from New York harbor.

Subgenus BALISTES

295 Balistes vetula Linnaeus

Blue-striped Triggerfish; Bessy Corka

Balistes vetula LINNAEUS, Syst. Nat. ed. X. I. 329. 1758, Ascension Island; GÜNTHER, Cat. Fish. Brit. Mus. VIII. 215. 1870; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 855, 1883; H. M. SMITH, Bull. U. S. F. C. 1897, 103, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1703, 1898.

Body shaped as in B. carolinensis, its greatest depth five ninths of total length without caudal. Head one third of total length without caudal. Lateral line placed as in B. carolinensis, but the median part, from base of first dorsal to front of caudal peduncle wanting in the adult, branch on cheek ceasing opposite gill opening; cross branch present; ventral flap well developed, with slender, sharp spines. Scales on head much smaller and more crowded than those on body. Third dorsal spine rather shorter and weaker than second, remote from it. Caudal fin widely forked, the lobes filamentous and about equal. Dorsal in adult filamentous at tip. Anal little elevated anteriorly. D. III, 29; A. 27; lateral line 63.

Two curved, bluish, dark-edged bands on the side of the head, the lower from the angle of the mouth towards the throat, the

upper from above the snout to the root of the pectoral; a black light-edged line, similarly curved below the eye; several other similar lines radiating from the eye; caudal fin margined above and below with bluish, and with an intramarginal bluish band; dorsal and anal fins with transverse bluish bands; young with some irregular oblique black lines following the rows of scales.

The blue-striped triggerfish is common in the West Indies and occurs occasionally northward on our coast as far as Cape Cod. According to Dr Smith it is found in Vineyard Sound every season, mostly in September, adult specimens being taken in some numbers in the traps at Menemsha. During summer and fall the young, 1½ or 2 inches long, are found at the surface in Vineyard sound in gulf weed and also around the shores.

Family MONACANTHIDAE

Filefishes

Genus MONACANTHUS Cuvier

Body short and deep, very strongly compressed, covered with minute, rough scales. Mouth very small; upper jaw with a double series of incisorlike teeth, usually 6 in the outer and 4 in the inner series; lower jaw with about 6 incisors in a single series; teeth connivent, unequal; gill opening a small slit, shorter than the eye, nearly vertical, below the posterior part of the eye, and just in front of upper edge of pectoral. Dorsal spine large, armed with two series of retrorse barbs, and no conspicuous filaments; second dorsal and anal fins similar to each other, of about 25 to 35 rays each; caudal fin moderate, rounded; pelvic bone with a blunt, movable spine, the bone connected by a movable flap of varying size; side of tail often with a patch of spines, specially in the males. Vertebrae 7+11 to 14=18 to 21. Species very numerous, in warm seas, most of them reaching a small size. All are lean fishes with leathery skin and bitter flesh, unsuited for food.

Subgenus STEPHANOLEPIS Gill

296 **Monacanthus hispidus** (Linnaeus)

Filefish

Balistes hispidus LINNAEUS, Syst. Nat. ed. XII, 405, 1766, Carolina.
Balistes broccus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 467, 1815, New York.

Monacanthus massachusettensis De Kay, N. Y. Fauna, Fishes, 336, pl. 57, fig. 187, 1842, Massachusetts Bay; Storer, Hist. Fish. Mass. 231, pl. XXIV, fig. 4, 1867.

Monacanthus setifer De Kay, N. Y. Fauna, Fishes, 337, pl. 59, fig. 194, 1842, New York Harbor; Goode & Bean, Bull. Essex Inst. XI, 4, 1879.

Monacanthus broccus De Kay, N. Y. Fauna, Fishes, 335, pl. 56, fig. 183, 1842; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 856, 1883.

Monacanthus hispidus Bean, Bull. U. S. F. C. VII, 133, 1888; 19th Rep. Comm. Fish. N. Y. 241, 1890; Bull. Am. Mus. Nat. Hist. IX, 369, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 104, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1715, 1898, pl. CCLIX, fig. 635, 1900; Bean, 52d Ann. Rep. N. Y. State Mus. 107, 1900, Great South Bay.

Body rather deep, the length being one and three fourths times the depth and three and two fifths times the length of the head; jaws subequal; eyes large, more than one third length of snout; gill opening about as long as eye, separated from the eye by an interspace nearly equal to its length; anterior profile slightly concave; dorsal spine somewhat shorter than snout, inserted above posterior part of eye, stout, rough, armed behind with two rows of retrorse barbs; first ray of soft dorsal sometimes filamentous, one half of total length without caudal; pectorals small, one half length of snout; pelvic bone long, ending in a short, blunt, movable spine, beyond which the abdominal flap does not extend; length of free edge of flap when expanded not greater than diameter of eye; scales minute, each with a crest of about three prickles, those on the caudal peduncle villous, those on the ventral flap larger, elongate; no naked areas; recurved spines on tail. Length 10 inches. D. I–32 to 33; A. 32 to 33; P. 15.

Dull greenish mottled with darker; fins olivaceous, somewhat blotched. Massachusetts bay to tropical seas; abundant on our South Atlantic coast. Also found through the West Indies to Brazil, in the Canaries and Madeira.

Mitchill and De Kay both recorded the filefish from New York, where it was not uncommon in summer.

This fish is taken in Gravesend bay in moderate numbers occasionally in the fall. Individuals were sent from there in September and November 1897. Some were living in a tropical tank and feeding freely on December 11. A single specimen was taken at Point of Woods, Great South bay, Aug. 16, 1898.

In the vicinity of Woods Hole Mass. according to Dr Smith, it occurs every year; some years rather scarce, some years abundant. In 1897 it was extremely numerous in July and August, and several hundred were often taken in one day in the seine. It may often be obtained under gulf weed, but is usually most plentiful in eelgrass and rockweed. No large fish are observed, the size ranging from 1 inch to nearly 4 inches. The smallest are rather uniformly dull brownish or greenish yellow in color, but those 3 or 4 inches long are mottled with white and several shades of dark green. In aquaria, small filefish often annoy and injure other fish, biting their fins, eyes, and other parts.

At Beesley's Point N. J. the writer seined an individual, Aug. 23, 1887, which had several parasites attached to the fins.

Genus ALUTERA Cuvier

Body oblong or rather elongate, strongly compressed, covered with minute, rough scales; mouth and teeth essentially as in Monacanthus, but the lower jaw more projecting, so that the lower teeth are directed obliquely upward and backward; gill opening an oblique slit, longer than eye, situated below and in advance of eye, its posterior end behind base of pectorals; pelvic bone long, falcate, movable under the skin, without spine at its extremity; dorsal spine small, inserted over the eye, rough, but without barbs; soft dorsal and anal long, each of 36 to 50 rays; caudal fin convex; pectorals small.

Subgenus CERATACANTHUS Gill

297 Alutera schoepfii (Walbaum)

Orange Filefish

Balistes schoepfii WALBAUM, Art. Gen. Pisc. 461, 1792, Long Island.
Balistes aurantiacus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 468, pl. VI, fig. 1, 1815, New York; adult.
Balistes cuspicauda MITCHILL, Am. Month. Mag. II, 326, March, 1818, New York; young.
Aluteres cuspicauda DE KAY, N. Y. Fauna, Fishes, 338, pl. 59, fig. 192, 1842, New York; young.
Monacanthus aurantiacus GÜNTHER, Cat. Fish. Brit. Mus. VIII, 254, 1870.
Alutera schoepfii JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 858, 1883; BEAN, Bull. U. S. F. C. VII, 134, 1888.

Alutera schoepfii Goode & Bean, Bull. Essex Inst. XI, 3, 1879; Bean, Bull. Am. Mus. Nat. Hist. IX, 369, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 104, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1718, 1898, pl. CCLX, fig. 636, 1900; Bean, 52d Ann. Rep. N. Y. State Mus. 107, 1900.

Body oblong, rather elongate, narrowed posteriorly; the greatest depth four ninths or nearly one half of total length without caudal; least depth of caudal peduncle nearly one third length of head. Profile of head very oblique; space between dorsals almost horizontal; ventral outline convex. Head short, its length contained three and one fourth times in total without caudal; the gill opening oblique, two and one half times as long as the eye; eye small, one fifth as long as the head; twice its own diameter from top of head, and placed far back over the posterior part of the gill opening; snout one fourth of total length without caudal; mouth very small, the lower jaw prominent. Dorsal spine slender, varying greatly in length, placed over the eye. Interspace between the dorsals as long as the head. Base of second dorsal one third of total length without caudal; the longest dorsal ray equals one third length of dorsal base; the outline of the fin greatly convex. Caudal moderately long in adult, rounded behind, much produced in young; the middle rays in adult as long as the snout. Anal similar to soft dorsal, but extending farther back, its base somewhat longer than dorsal base, its longest rays equal to longest of dorsal. Pectoral short, one third as long as the head. Scales minute, shagreenlike, uniform over the body. D. I, 36; A. 38.

Coloration nearly uniform dirty olive gray, varying to orange yellow, often, specially when young, mottled above with darker bluish or dull orange; caudal sometimes dusky, edged with white, usually dull yellowish in the adult. Length 24 inches.

The orange filefish is found from Cape Cod to the Gulf of Mexico, the young usually abundant every summer on the south shore of Long Island and in the bays.

The young are rather common in Gravesend bay in August, September, October, and sometimes as late as November. Adults are rarely seen. The species will not survive the winter except

in warmed water. It feeds freely when the temperature is agreeable.

Young individuals were obtained in 1898 at the ocean beach, Southampton, Long Island, August 3, Islip, August 18, and Fire Island inlet, September 16. No adults were seen; the largest example was about 9 inches long. In 1901, an adult was obtained from Watts's pound, in Clam Pond cove, August 13, and another was speared in Fire Island inlet, August 1; no young were observed.

At Woods Hole Mass. according to Dr Smith, it is rather common every year in August and September. The largest are 18 inches long, the smallest 3 inches. The position constantly assumed in the aquarium is with the head down. Succulent algae are often eaten by the fish in captivity, the long branches of some species being bitten off and swallowed in a surprisingly short time. The color of the young is a dirty white, with large reddish-brown mottlings or blotches; the larger are orange-colored with the same mottlings as when young.

The species is seldom found north of Cape Cod. An individual taken at Forest River lead works, Salem, Mass. Aug. 9, 1845, was preserved in the museum of the Essex institute. At Somers Point N. J., a few young were found in August and September, but the adults were absent. This is called sunfish at Somers Point.

Suborder OSTRACODERMI

Trunkfishes

Family OSTRACIIDAE

Genus LACTOPHRYS Swainson

Trunkfishes with the carapace three-angled, the ventral surface flat or concave, never carinate; carapace closed behind the anal fin; carapace with or without frontal and abdominal spines; dorsal rays nine or 10; caudal rays always 10. This genus contains five species, four of them American, and differs from the Old World genus Ostracion only in the form of the carapace. The median dorsal ridge of the carapace is much more developed than the others, so that the body is three-sided and

three-angled, instead of four-sided and four-angled, as in Ostracion. Though this character is a striking one it is not one of high structural importance. Hollard and Bleeker have discarded it as being of no real systematic value. All writers agree that the species of the group are most closely related, and that the relations of the species are closer than they appear. We think, with Dr Goode, that the shape of the carapace affords "the most reliable guide in the arrangement of the species of the genus," and we think it not improper to accord generic distinction to the three-angled species, as distinct from the more specialized four-angled forms. *Jordan and Evermann.*

298 Lactophrys trigonus (Linnaeus)

Subgenus LACTOPHRYS

Trunkfish; Cuckold

Ostracium trigonus LINNAEUS, Syst. Nat. ed. X, 330, 1758.

Ostracium trigonum JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 853, 1883.

Ostracion trigonus GÜNTHER, Cat. Fish. Brit. Mus. VIII, 256, 1870.

Ostracion yalei STORER, Bost. Jour. Nat. Hist. I, 353, pl. 8, 1837, Holmes Hole, Marthas Vineyard.

Lactophrys yalei DE KAY, N. Y. Fauna, Fishes, 342, 1842, after STORER; STORER, Mem. Am. Ac. VIII, 429, pl. 35, fig. 3, 1861.

Lactophrys trigonus POEY, Memorias, II, 362, 1861; BEAN, Bull. Am. Mus. Nat. Hist. IX, 369, 1897; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1723, 1898, pl. CCLXIII, fig. 641, 641a, 1900; H. M. SMITH, Bull. U. S. F. C. 1897, 104, 1898.

Body three-angled and with greatly compressed, thin edges; the greatest height one half of total length without the caudal. The caudal peduncle long and slender, its least depth three fourths diameter of eye. Each ventral ridge with a large, flat spine; no spine in front of eyes. Dorsal ridge high, greatly compressed, descending rapidly forward to opposite posterior margin of orbit and backward to caudal peduncle; carapace open behind the dorsal fin. Eye one third as long as the head; a pronounced supraoccipital ridge, the interorbital space exceeding diameter of eye. Dorsal base five sixths as long as the eye; longest dorsal ray one half as long as head. Anal farther back than dorsal and somewhat smaller. Length of gill opening not equal to eye.

D. 10; A. 10; P. 12.

Four teeth in each side of lower jaw.

Color olive gray or brownish; a faint blue spot in the center of each of most of the scales; nostril in a yellow spot; boundaries of upper scutes blackish, of lower bluish; outlines of various scutes behind gill opening black, forming a dusky area, specially distinct in the young; a similar smaller dusky area on side on level of eye; iris yellow; fins all pale olive; vent yellow; belly light olive, outlines of the scutes bluish; base of pectorals yellowish.

The trunkfish reaches the length of about 1 foot; it is common in the West Indies, the Bermudas, and the eastern part of the Gulf of Mexico, occasionally migrating northward in summer under gulf weed as far as Cape Cod. Dr Storer had it from Holmes Hole, on Marthas Vineyard. Dr H. M. Smith records no adults from the vicinity of Woods Hole Mass. but young individuals are not uncommon and are taken every year. They are found from July to October. On quiet days they are seen, singly or in scattered bodies, in the eelgrass about the wharves. The largest specimens secured by Dr Smith are 1 inch long, and the smallest $\frac{1}{4}$ inch. They are taken under the gulf weed, in surface tow nets and in shore seines. Several dozen have been obtained at one seine haul.

De Kay knew the fish only from the description by Dr Storer.

The only individual taken in Gravesend bay was found in August 1897; it was $\frac{3}{4}$ inch long. The fish lived a very short time in a balanced jar, though it appeared to feed freely upon minced hard clam.

Suborder GYMNODONTES

Family TETRAODONTIDAE

Puffers

Genus LAGOCEPHALUS Swainson

Body comparatively elongate; skin smooth or variously prickly, the prickles most developed on the abdomen; abdomen capable of very great inflation. Dorsal and anal rather long, falcate, of 12 to 15 rays each; caudal lunate. Nostril without distinct papilla, each one with two distinct openings; mucous

tubes on upper part of head and on sides of body very conspicuous. Lower side of tail with a fold. Species reaching a rather large size, chiefly tropical, one of them, L. lagocephalus L., reaching the coasts of southern Europe. Vertebrae in increased number (about 8+13=21). The increased number of vertebrae and of rays in the vertical fins mark a transition toward the allied family, Chonerhinidae, in which there are about 29 vertebrae, the dorsal rays about 35, the anal 30.

299 Lagocephalus laevigatus (Linnaeus)

Smooth Puffer; Rabbitfish

Tetrodon lacrigatus Linnaeus, Syst. Nat. ed. XII, 411, 1766, Charleston, S. C.; Mitchill, Rep. Fish. N. Y. 28, 1814; Günther, Cat. Fish. Brit. Mus. VIII, 274, 1870.

Tetraodon lacrigatus De Kay, N. Y. Fauna, Fishes, 329, pl. 56, fig. 182, 1842.

Tetrodon curvus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 474, 1815; New York; young.

Tetrodon mathematicus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 474, pl. VI, fig. 6, 1815.

Lagocephalus lacrigatus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 860, 1883; Bean, Bull. U. S. F. C. VII, 133, 1888; Bull. Am. Mus. Nat. Hist. IX, 369, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 104, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1728, 1898, pl. CCLXIII, fig. 642, 1900; Sherwood & Edwards, Bull. U. S. F. C. 1901, 30, 1901.

Body elongate, stout, its depth about one fourth or two ninths of total length without the caudal. Caudal peduncle rather slender, tapering, its least depth about equal to diameter of eye. Head short, very obtuse in front, its length two sevenths of total without the caudal. Mouth very small, terminal. Nostrils midway between eye and tip of snout. Snout twice as long as the eye, which is one fourth as long as the head, and two thirds of width of interorbital space. Dorsal and anal fins opposite, about midway between eye and origin of middle caudal rays; each fin on a fleshy base. Base of dorsal two sevenths as long as the head; longest dorsal ray about one half as long as the head. Anal equal in size to dorsal. Caudal fin lunate, the middle rays as long as the snout; fold of skin on side of tail very distinct. Back and sides smooth; belly prickly, the spinous region extending backward from the throat nearly to the vent

and on the sides as high as the base of the pectoral; spines rather large, three-rooted, well separated, and with no smaller ones intermixed. Pectoral short and deep, its longest rays nearly one half as long as the head.

D. 14; A. 12; P. 15.

Upper parts greenish, sides and lower parts silvery white; no distinct markings.

The smooth puffer is a common resident of tropical seas, on our coast ranging from Cape Cod to Brazil. It reaches a length of 2 feet. According to Parra its flesh is poisonous. No recent observations have been recorded, however, on this subject.

In the waters of Cape Cod the species is not common though a few specimens are taken annually in traps in Buzzards bay and Vineyard sound, chiefly in September and October. The young are not found at all, the individuals observed being 11 or 12 inches long. During 1900 several specimens were taken in the vicinity of Woods Hole Mass. The Rhode Island Fish Commission secured three specimens in Narragansett bay, the largest weighing 10 pounds.

Occasionally taken in the fall in Gravesend bay. Five young were obtained in October 1897, but all of them died in November, notwithstanding that they had been taking food readily. The temperature could not be endured.

Though this fish was unknown to the fishermen met in Great Egg Harbor bay in 1887, it was moderately common there, 13 examples having been taken from August 27 to September 18. It has the same habit as the swellfish of inflating its abdomen.

Genus SPHEROIDES Lacépède

Body oblong, not elongate; skin variously prickly or smooth, sometimes with cirri. A single, short, simple nasal tube on each side, with two rather large openings near its tip. Dorsal and anal fins short, little falcate, of six to eight rays each; caudal truncate or rounded, rarely slightly concave. Vertebrae $8 + 10 = 18$. Frontal bones expanded sidewise and forming the lateral roof of the orbit, the postfrontals limited to the posterior portions. Species numerous, in warm seas; largely

American. Our species represent two well marked subgenera, the extremes of which appear very different from each other so far as the skulls are concerned. Some of the typical species of Spheroides approach Canthigaster in the narrowness of the frontal area.

Subgenus SPHEROIDES

300 Spheroides maculatus (Bloch & Schneider)

Swellfish; Puffer

Tetrodon hispidus var. *maculatus* Bloch & Schneider, Syst. Ichth. 504. 1801, Long Island.

Tetrodon turgidus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 473, pl. VI, fig. 5, 1815, New York; Günther, Cat. Fish. Brit. Mus. VIII, 285. 1870; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 861, 1883; Bean, Bull. U. S. F. C. VII, 133, 1888; 19th Rep. Comm. Fish. N. Y., 242. 1890.

Tetraodon turgidus De Kay, N. Y. Fauna, Fishes, 327, pl. 55, fig. 178. 1842.

Spheroides maculatus Jordan & Edwards, Proc. U. S. Nat. Mus. 232. 1886; Bean, Bull. Am. Mus. Nat. Hist. IX, 369, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 104, 1898; Jordan & Evermann, Bull. 47. U. S. Nat. Mus. 1733, pl. CCLXIV, fig. 645, 1900; Bean, 52d Ann. Rep. N. Y. State Mus. 108, 1900.

Body fusiform, thick, its width and depth about equal and one third of total length without the caudal. Head moderately large, three eighths of the length without caudal. Eye small, about two fifths of interorbital width and one ninth as long as the head. Snout long, four sevenths as long as the head. Interorbital space slightly concave; profile not steep, depressed in front of the eyes. Dorsal origin twice as far from middle of eye as from base of middle caudal rays; base of dorsal fin as long as the eye; longest ray one third as long as the head. Anal origin under the end of dorsal base, the fin about equal to dorsal. Caudal convex, the middle rays two fifths as long as the head. Pectoral deep, but short, its upper rays three eighths as long as the head. Distance of nostrils from front of eye one half their distance from tip of snout. Sides of head and body always prickly; back prickly from upper lip to base of dorsal; belly prickly from lower lip to vent; prickles all similar, small, mostly three-rooted, stiff and close set, rather largest pos-

teriorly on back and belly, never obsolete; sides without cirri. D. 7; A. 6; C. 7; P. 16.

Color darkish olive green on the upper part of the head, body and tail, with a yellowish tinge along the sides. Sides and under surface white. Along the sides from beneath the eye to the caudal fin is an indefinite series of six to eight oblong black blotches, which occasionally take the appearance of transverse bars. De Kay observed some individuals which were nearly a uniform black above. Caudal fin nearly uniform pale, the tip darker.

The swellfish inhabits the Atlantic coast from Cape Ann to Florida; it grows to a length of 10 inches. In most localities the fish is not eaten, but at Somers Point N. J. certain persons professed to find in it excellent food qualities. De Kay states that the species is scarcely ever eaten in New York.

This species is known also by the additional names, puffer, blower, eggfish, swelltoad, sucking toad, toadfish (at Somers Point N. J.) It is the puffer and toadfish of Mitchill's *Fishes of New York.*

The swellfish is extremely abundant about the eastern end of Long Island, and is caught by hundreds at a time in pound nets during the summer. The writer has taken it at the following localities in Great South bay: Fire Island inlet, Oak Island beach, Clam Pond cove, Islip, Cherry Grove, Nichols's Point, Blue Point. In Gravesend bay the species is found at all times except during the cold months; it is hardy in captivity, but can not be kept with other fish because of its predatory habits.

In the vicinity of Woods Hole, according to Dr Smith, it appears about June first, and is abundant during the run of scup. It is common throughout the summer at the head of Buzzards bay. The spawning season is June 1 to 10. From about July 1 to October 15, the young, from $\frac{1}{2}$ inch to 1 inch long, are extremely abundant at Woods Hole, frequenting chiefly sandy beaches, where as many as 100 are often taken in one seine haul. The fish leaves as soon as cold weather sets in.

The name swellfish is derived from its habit of inflating itself by means of air or water. It can be made to inflate itself by scratching its belly. During the process of inflation the fish makes a sucking sound, from which doubtless comes the Chesapeake bay name of "sucking toad." Mitchill gives the following account of the inflation:

The air is inhaled with a sucking or swilling noise. When received into the cavity it is confined there by a valve in the throat. This valve is so strong and so tight that not a particle of air can escape. The hardness equals that of a football, and the fish will bear to be kicked about without discharging it. I have seen them stamped upon and still retain their charge of air. I have known them to bounce from the surface of a rock, against which they have been thrown, as turgid as ever. And it is a piece of sport, common enough among fishermen, to burst them between two stones, when the air is let loose with a noise almost equal to the report of a pistol.

The habit of inflation is a protective one. By means of it the fish can readily escape from the closed hand unless particular effort is made to retain it. When the abdomen is inflated the swellfish often remains on the surface of the water, and is driven by wind and tide till it desires to sink, when the air is suddenly discharged and the abdomen returns to its normal state.

It often takes a baited hook, notwithstanding the small size of its mouth and its clumsy teeth.

Subgenus CHEILICHTHYS Müller

301 Spheroides testudineus (Linnaeus)

Globefish; Blowfish

Tetrodon testudineus LINNAEUS, Syst. Nat. ed. X, 332, 1758; GÜNTHER, Cat. Fish. Brit. Mus. VIII, 282, 1870; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 861, 1883.

Spheroides testudineus JORDAN & EDWARDS, Proc. U. S. Nat. Mus. 239, 1886.

Spheroides testudineus JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1734, 1898, pl. CCLXV, fig. 646, 646a, 1900.

Body fusiform, subterete, moderately elongate, its greatest width and depth equal, and two sevenths of total length without caudal. Caudal peduncle comparatively stout, its least depth one third length of head, the width not decreasing rapidly

toward the base of the caudal. Head one third of total length without caudal; eye small, its length nearly one fourth length of snout and nearly one seventh that of head; interorbital width two fifths length of head; nostrils one diameter of the eye in advance of eye. Gill opening one fourth length of head. Origin of dorsal fin twice as far from front of eye as from root of middle caudal rays. Dorsal base one fifth as long as the head, two fifths as long as longest dorsal ray. Anal origin slightly behind dorsal origin, the anal fin a little smaller than the dorsal, and mostly opposite to it. Caudal slightly concavo-convex, the lower lobe a little the longer, the middle rays two thirds as long as the head. Pectoral very deep but short, its longest ray two fifths as long as the head. Lateral line beginning behind the nostril, extending under the nostril to the middle of the snout, thence curving back on the cheek, ascending below and behind eye in a broad curve, its highest point on the level of the eye, to the middle of the caudal peduncle and thence nearly straight to the base of the caudal. Small, sparsely set prickles on back from nape to about middle of total length; larger, closely set prickles on belly from throat to vent, extending up to lower edge of pectoral fin; these prickles rarely obscure or absent; sides sometimes with cirri.

Back dark brownish or grayish and with whitish narrow curved lines and streaks, one of these usually a rhomb in the middle of the back surrounded by a long ellipse which often contains also a short crescentic streak. Two half ellipses on posterior part of back between dorsal and caudal fins. Two pale streaks across the interorbital space. Entire body and head, except back and belly, profusely covered with roundish black spots, the largest smaller than the pupil. A dark bar at base of pectoral. Caudal dusky at base, then pale, the posterior half blackish. D. 8; A. 7; C. 10; P. 15.

The globefish abounds in the West Indies, occasionally ascending rivers, and sometimes ranging northward in the Gulf Stream as far as Newport R. I. No specimens have yet been recorded from New York waters, but its occurrence is to be

expected in bays of the south side of Long Island. The species reaches the length of 7 or 8 inches; it is known in Cuba as the Tambor.

302 Spheroides trichocephalus (Cope)

Hairy Blowfish

Tetrodon trichocephalus COPE, Proc. Ac. Nat. Sci. Phila. 120, 1870, Gulf Stream off Newport, R. I.; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 862, 1883.

Sphaeroides trichocephalus JORDAN & EDWARDS, Proc. U. S. Nat. Mus. 236, 1886.

Spheroides trichocephalus JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1737, 1898.

Head two sevenths of total length; eye two sevenths as long as the head; interorbital width four fifths diameter of eye. Profile suddenly descending from prefrontal region to premaxillary, arched from the former point backward; belly spinous to near vent; dorsal region spinous from a little behind the nares to above the ends of the pectoral fins; spines on the head long, close set, like seal bristles; caudal fin truncate, with prominent angles.

D. 8; A. 7.

Brownish above, faintly vermiculated with lighter; sides yellowish, becoming white below; fins uniform light yellow; a brown spot at base of pectoral. (After Cope)

The hairy blowfish is known only from the small specimen 4 inches long described by Professor Cope; the specimen was taken in the Gulf Stream off Newport. Jordan and Evermann suggest that it may be the young of Spheroides pachygaster (Müller & Troschel), from Barbados. Possibly it may be nearer to S. nephelus (Goode & Bean), Proc. U. S. Nat. Mus., 412, 1882, a southern species known from Georgia to Texas.

No specimens have been recorded from waters of New York.

Family DIODONTIDAE

Porcupine Fishes

Genus TRICHODIODON Bleeker

Body oblong, little depressed; nasal tentacle present; dermal ossifications very small, each with a pair of lateral roots, and

each terminating in a fine, flexible, bristlelike spine; fins as in Diodon, of which the species are possibly the very young.

303 Trichodiodon pilosus (Mitchill)

Hairy Porcupine Fish

Diodon pilosus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 471, pl. VI, fig. 4, 1815; supposed to be from New York Harbor; specimen 1½ inches long.

Trichodiodon pilosus Günther, Cat. Fish. Brit. Mus. VIII, 316, 1870; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 862, 1883, name but probably not description which is from De Kay; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1743, 1898.

Mitchill's description as given by Jordan and Evermann is as follows: "Hairy diodon (Diodon pilosus), with a covering of bristly hair. Length about 1½ inches; breadth less than ½ inch; depth nearly a quarter, making a blunt lump of a fish; covered all over—back, sides, head and belly—with bristly hair. The bristles strong and flexible, without the power to scratch or to prick; hair about ¼ inch in length. Complexion dun or brown, with spots on the back, sides, and toward the belly; has, at first glimpse, the appearance of a young mouse. Mouth small, midway, and horizontal. Eyes vertical, lateral, and large. No ventral fins. Pectorals broad. Dorsal and anal very far back, and no hair between them and the tail. This is but a small projection from the thick and clumsy body, and is terminated by a fin of seven rays. Dorsal, anal, and pectoral fins contain each about 13 rays."

Günther (Cat. Fish. Brit. Mus., VIII, 316, 1870) describes a young example, ⅞ inch long, and by some authors supposed to be of the same species as Mitchill's hairy diodon, as follows: "Trichocyclus. Jaws without median suture. Body covered with long, hairlike bristles. No nasal tentacle. (Dorsal and anal fins absent ?). 1. Trichocyclus erinaceus.

Owing to the indifferent preservation of the specimen, I can give but an incomplete description of it. It is ⅞ inch long, and the longest hairs (which are those on the sides) about ⅜ inch. The entire body, except the snout, is covered with such hairs. The jaws are prominent, depressed; and the upper terminates

in a slight hook, overlapping the lower jaw. The caudal fin is distinct, and the pectoral a narrow fringe behind the gill opening; but I am unable to find a trace of the dorsal and anal fins." Habitat unknown.

Under the name Diodon pilosus De Kay describes and figures a specimen 2 inches long which he considered identical with the Diodon pilosus of Mitchill, but which may be the young of Diodon hystrix, a species not yet recorded in New York waters.

Genus CHILOMYCTERUS Bibron

Body broad, depressed, moderately inflatable. Dermal spines short, stout, immovable, triangular, each with three roots; nasal tube simple, with two lateral openings; the tube sometimes rounded, sometimes flattened, and with the partition feeble and easily torn so that the tentacle appears divided; caudal peduncle short; fins small, formed as in Diodon; jaws without median suture. Species numerous, of smaller size than those of Diodon, the spines broader and lower, their bases forming a coat of mail.

Subgenus CYCLICHTHYS Kaup

304 Chilomycterus schoepfi (Walbaum)

Spiny Boxfish; Burfish; Cucumberfish

Diodon schoepfi WALBAUM, Art. Gen. Pisc. 601, 1792, Long Island.

Diodon maculostriatus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 470, pl. VI, fig. 3, 1815, New York; DE KAY, N. Y. Fauna, Fishes, 323, pl. 56, fig. 185, 1842.

Diodon rivulatus CUVIER, Mém. Mus. Hist. Nat. IV, 129, pl. 6, 1818, New York.

Diodon nigrolineatus AYRES, Bost. Jour. Nat. Hist. IV, 68, 1842, Brookhaven, Long Island.

Chilomycterus geometricus GÜNTHER, Cat. Fish. Brit. Mus. VIII, 310, 1870; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 863, 1883; BEAN, Bull. U. S. F. C. VII, 132, 1888.

Chilomycterus schoepfii BEAN, Bull. Am. Mus. Nat. Hist. IX, 369, 1897.

Chilomycterus schoepfi JORDAN and EVERMANN, Bull. 47, U. S. Nat. Mus. 1748, 1898, pl. CCLXVI, fig. 649, 1900; H. M. SMITH, Bull. U. S. F. C. 1897, 105, 1898.

Body elliptic, a little broader than deep at gill openings, the depth four ninths of total length without caudal. Caudal

peduncle very short, one third as long as the head, its least depth one half of its greatest depth, and less than diameter of eye. Eye placed high, one fourth as long as the head, about equal to width of gill opening; interorbital space broad, concave. Snout nearly equal to eye. A cirrus, longer than pupil, above each eye. Origin of dorsal four times as far from tip of snout as from base of middle caudal rays. Dorsal base one third as long as the head; longest dorsal ray one half as long as the head. Anal immediately under the dorsal and about equal to it in size. Caudal rounded, the middle rays as long as the postorbital part of the head. Pectoral one half as long as the head, its depth when expanded six sevenths of length of head. A small cirrus on chin. About nine spines between eye and tail, their hight about two thirds diameter of eye; spines on belly much smaller, partly embedded in skin; some of the posterior with cirri; spines on caudal peduncle; anterior root of each spine little if any larger than others. D. 12; A. 10; C. 9; P. 20.

Color of a living specimen as given by De Kay: "Bright sea green above, with longitudinal olive-brown irregular stripes on the back and upper part of the sides; on the cheeks, below the eyes, these stripes are oblique; transverse across the snout, and sloping downward over the fleshy portion of the tail. The large olive-brown spots are irregularly rounded, occasionally approaching a quadrate form, and eight in number; one on each side, above the base of the pectorals, of an oblong oval form; one on each flank, behind and partially covered by the pectoral, irregularly subquadrate; one on each side of the base of the dorsal, ascending upon that fin; this is considered by Cuvier as a single spot; finally a small oblong spot on each side, about midway between the dorsal fin and the vent. Abdomen light-colored, with a light tinge of pink. Spines on this portion of the body inclining to orange. Pupils dark greenish; irides yellow." Other writers speak of the spots and stripes as of a black color, and state that the belly is often black in the young.

The spiny boxfish grows to the length of ten inches. It is found on our coast from Cape Cod to Florida. The body is

capable of considerable inflation, but less than in the common swellfish.

A young example, 3 inches long, seined at Longport N. J. Aug. 29, 1887, is much less elongate than the adult, and has the orbital tentacles greatly developed. The black spot which is present near the anal origin in the adult is absent in the young. The species is known as "Cucumberfish" at Somers Point N. J. It takes the hook. The fish is found occasionally in small numbers from May to October in Gravesend bay, but no very small ones are seen. It lives in the aquarium in winter only in water heated to a temperature of 68° to 70° F.

305 Chilomycterus fuliginosus (De Kay)

Burfish; Unspotted Balloonfish

Diodon fuliginosus De Kay, N. Y. Fauna, Fishes, 324, pl. 55, fig. 181, 1842. New York Harbor; Baird, Ninth Ann. Rep. Smith Inst. 351, 1855. Great Egg Harbor River, N. J.

Chilomycterus geometricus subsp. (?) *fuliginosus* Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 864, 1883.

Chilomycterus fuliginosus Bean, Bull. U. S. F. C. VII, 133, 1888; 19th Rep. Comm. Fish. N. Y. 243, 1890.

The following is the original description of the species:

Body subcubical, rather more slender toward the tail. Irregular series of triangular spines on the upper surface, the extremities of which, in the living animal, are furnished with long strips of membrane. Similar spines, but more numerous, smaller and recurved, on the abdomen. Three spines over each orbit, and another equidistant between each orbit. Lips fleshy and susceptible of being drawn over the teeth. Three or four minute barbels under the chin. Pectorals short and broad, with a slightly sinuous margin; the upper rays longest. Dorsal placed far back, and obtusely pointed. The anal fin long, placed on an elongated fleshy base. Tail slender, supporting a lanceolate caudal fin. All the fins exceedingly feeble and delicate.

Color. Above dark olive-green, tinged with brown, with meandering dusky lines. . . chin yellowish white. Abdomen black; but the bases of the spines are bright orange, which so far predominates as to give this color to the whole underside.

Length, 2 inches. Depth and transverse diameter, 1 inch. Fin rays, D. 14; P. 22; A. 8; C. 9.

This species, which might be mistaken for the young of the preceding, [the spot-striped balloonfish] is readily distinguished

by its lanceolate tail. . . The specimen which furnished me with the above description was found in a net in the harbor of New York in the latter part of October.

By some ichthyologists this has been considered the young of the common C. geometricus, but by Drs Goode and Bean, who base their opinion on a specimen taken at Block Island and the example found in Great South bay in 1884, near the Blue Point Lifesaving station, it is accepted as a valid species. Professor Baird recognized it also in Great Egg Harbor river, N. J. in 1854.

The following is a recent description:

Entire body covered with large three-rooted spines, which are numerous and close set, specially on the belly; spines of the belly as large or even larger than those on the back; not embedded. D. 12; A. 10.

Dark brownish olive above, with wavy dusky lines; belly black, the base of the spines bright orange. Atlantic coast, from Cape Cod southward; not common.

Family MOLIDAE

Headfishes

Genus MOLA Cuvier

Body ovate, strongly compressed, covered with a thick, rough, leathery, elastic skin, which is without bony plates. Profile forming a projecting fleshy nose above the mouth. Dorsal fin beginning not far behind pectorals, short and high, falcate, confluent with the anal around the tail; no large spines on the body. Clumsy fishes, found in most warm seas, reaching a great size; the young (Molacanthus) with the body deeper, much compressed, without trace of caudal fin, its place taken by a row of marginal spines.

306 **Mola mola** (Linnaeus)

Sunfish; Mola; Headfish

Tetrodon mola LINNAEUS, Syst. Nat. ed. X. 334, 412, 1758, Mediterranean.
Cephalus brevis MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 471, 1815.
Diodon carinatus MITCHILL, Ann. Lyc. Nat. Hist. N. Y. II. 264, pl. 5, fig. 1, 1815, New York; young.
Acanthosoma carinatum DE KAY, N. Y. Fauna, Fishes, 330, pl. 55, fig. 179, 1842.

Orthagoriscus mola STORER, Rep. Ichth. Mass. 170, pl. 3, fig. 1, 1839; DE KAY, N. Y. Fauna, Fishes, 331, pl. 59, fig. 193, 1842, New York Bay; STORER, Hist. Fish. Mass. 226, pl. XXXIV, fig. 2, 1867; GÜNTHER, Cat. Fish. Brit. Mus. VIII, 317, 1870.

Orthagoriscus analis AYRES, Proc. Cal. Ac. Sci. II, 31, fig. 54, 1854, San Francisco.

Mola rotunda CUVIER, Tableau Elem. Nat. Hist. 323, 1798, *fide* JORDAN & EVERMANN; GOODE & BEAN, Bull. Essex Inst. XI, 3, 1879; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 865, 1883.

Mola mola JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1753, 1898, pl. CCLXVII, fig. 651, 1900; H. M. SMITH, Bull. U. S. F. C. 1897, 105, 1898, Vineyard Sound.

The length of the head is one third of the length of the body which is one and three fifths times the depth of the body; dorsal and anal fins high in front, rapidly decreased backwards; caudal fin low, and with a wavy outline; depth always more than half length, and in the young the vertical diameter exceeding the longitudinal; form varying with age, the body becoming more elongate, the fins comparatively shortened, the eye much smaller, and a hump being developed above the mouth, topped by an osseous tubercle. D. 17; A. 16.

Dark gray; sides grayish brown, with silvery reflections, belly dusky; a broad blackish bar running along the bases of the dorsal, caudal, and anal fins. Pelagic, inhabiting most temperate and tropical seas, swimming slowly near the surface, with the high dorsal fin exposed.

It ranges northward to San Francisco, Cape Ann, and England, occurring rarely in the West Indies. The Essex Institute has a specimen which was taken in Salem harbor in the summer of 1863. An individual, 4 feet long, was caught off Gloucester Mass. July 31, 1860. Dr Smith reports it rarer now than formerly in the vicinity of Woods Hole, Mass. It was not unusual to observe eight or 10 specimens annually in Vineyard Sound, but of late not more than one in a season is seen. In 1896 a 400 pound fish was seen off Tarpaulin Cove. A 200 pound specimen, caught off Great Harbor, was kept alive at the station for about a week in 1887. The sunfish are usually found there in August. Mr V. N. Edwards has opened a number of stomachs and found in them only ctenophores and medusae. The largest individual

recorded was captured at Redondo Beach, California, in June 1893; this was 8 feet 2 inches long and weighed 1800 pounds. The specimen mentioned by Mitchill and De Kay from lower New York bay, within Sandy Hook, was 54 inches long and weighed 200 pounds.

The sunfish is not edible. De Kay states that various parasites are frequently found adhering to its body; this is rendered easy on account of the sluggish movements of the fish.

The young sunfish is very different in appearance from the adult and has been described under various generic names and even referred to a distinct family.

Suborder LORICATI

Mail-cheeked Fishes

Family SCORPAENIDAE

Rockfishes

Group SEBASTINAE

Genus SEBASTES Cuvier

Body oblong, compressed. Head large, scaly above and on sides; cranial ridges well developed. Mouth terminal, very broad, oblique, the broad, short maxillary extending to below the eye; lower jaw projecting, with a bony knob at the symphysis, fitting into a rostral notch; villiform teeth on jaws, vomer and palatines. Eye very large, close to upper profile, preopercle with five diverging spines, opercle with two; suprascapular spines strong; gill rakers long, slender. Scales small, ctenoid, irregularly arranged; no dermal flaps. Dorsal fin continuous, very long, the spinous part much longer than the soft part, of 15 strong spines; anal spines three, strong; caudal emarginate; pectorals long, narrow. Branchiostegals seven. Vertebrae 12+19=31. Coloration mostly red. Ovoviviparous. One species known, in the North Atlantic.

307 Sebastes marinus (Linnaeus)

Rosefish; Norway Haddock

Perca marina LINNAEUS, Syst. Nat. ed. X, I, 290, 1758, Norway.

Sebastes norvegicus CUVIER & VALENCIENNES, Hist. Nat. Poiss. IV, 327, pl. 87, 1829; GÜNTHER, Cat. Fish. Brit. Mus. II, 95, 1860.

Sebastes norvegicus De Kay, N. Y. Fauna, Fishes, 60, pl. 4, fig. 11, 1842, off New York in deep water; Storer, Hist. Fish. Mass. 38, pl. VII, fig. 1, 1867.

Sebastes marinus Goode & Bean, Bull. Essex Inst. XI, 14, 1879; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 651, 1883; Goode & Bean, Oceanic Ichth. 260, pl. LXIX, fig. 248, 1896; H. M. Smith, Bull. U. S. F. C. 1897, 105, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1760, 1898, pl. CCLXVIII, fig. 653, 1900.

The depth of the body is contained two and four fifths times in the length of the body which is three times the length of the head. Body ovate; back elevated, the ventral outline straightish; top of head evenly scaled; interorbital space with two low ridges, between which it is concave; nasal spines present; cranial ridges moderate, rather low and sharp; preocular, supraocular, postocular, tympanic, and occipital ridges present, the latter with tips abruptly divergent; suprascapular spines very sharp and prominent; opercular spines long and sharp; subopercular spine prominent; preopercular spines slender and sharp, the second longest; suborbital stay not reaching preopercle; preorbital narrow, with two spines. Eye exceedingly large, three in head, more than twice as wide as interorbital space. Mouth very large, oblique; maxillary very broad, reaching middle of eye, its length two and one third in head; premaxillaries on level of middle of pupil; tip of lower jaw much projecting, with a conspicuous, pointed symphyseal knob; mandible and maxillary scaly; pseudobranchiae very large; gill rakers long, stiff and strong. Dorsal spines sharp, the longest about as long as eye; the fin deeply emarginate; soft rays not very high, higher than the spines; caudal narrow, moderately forked; anal spines moderate, graduated; the second a little shorter than eye; pectoral rather long, reaching vent, its base narrow; ventral reaching vent. Scales small, irregular, not strongly ctenoid. Peritoneum brownish. D. XV–13; A. III, 7; Lat. l. 40 (tubes); scales about 85.

Orange-red, nearly uniform, sometimes a dusky opercular blotch, and about five vague dusky bars on back. Peritoneum brownish.

The rosefish is abundant at the hundred fathoms line off the south coast of New England, and has been found in depths of

180 fathoms. It breeds abundantly in late summer at these depths, and there is no reason to believe that the young rise to the surface. The fry were caught by the bushel in the trawl net of the U. S. Fish Commission steamer *Fish Hawk*.

The species was originally described from Norway by Linnaeus. Cuvier had specimens from Miquelon Newfoundland. Day mentions a number of localities of its capture about the British Isles, but it is rare south of Faroe Islands. It occurs on the southwest coast of Spitzbergen, and on the Norwegian coast it is found everywhere from Christiania around to the Varanger-Fiord. It also occurs in Greenland, and from Labrador, as a shore form, as far south as Cape Cod, and in deeper water as far south as New Jersey.

In the Woods Hole region it was taken on the shore on Dec. 20, 1895 in Great Harbor. Seven or eight specimens, 3 inches long, were found in a hole on a flat where they had been left by the tide; four or five of these had been stranded and were dead; the others were alive when captured. Fishermen claim that they sometimes catch these fish in traps very late in fall at Provincetown. (After Smith)

De Kay has the following remarks upon the fish:

This is a very rare fish in our waters. It is called by our fishermen red sea perch, and they say it is only found in deep water. By the fishermen of Massachusetts it is known under the various names of rosefish, hemdurgon and snapper. Fabricius states that it is rather agreeable food, but meager. It feeds on flounders and other fish, and takes the hook readily.

The species reaches the length of 2 feet; it is frequently to be found in the Boston markets and is seen occasionally in the markets of New York with the skin removed on account of the hard scales.

Genus HELICOLENUS Goode & Bean

Body oblong, somewhat compressed; head large, ctenoid scales on its top, and on cheeks and opercles; several series of spinous ridges on head, but no occipital pit; mouth large, with bands of villiform teeth on jaws, vomer and palatines. Dorsal fin continuous, not deeply notched, with 10 stout spines and 10 to 12 rays; anal with three spines and six rays; pectoral broad,

fan-shaped, with rays arranged in three groups, the first of two simple rays, the second of eight or nine branched rays, the third of eight simple rays, sometimes prolonged, with their tips tendrillike and free from membrane for one half their length or less; soft dorsal with tips free from membrane; suborbital keel smooth, or with a single anterior spine under eye; preorbital with spines small and hidden beneath the skin. Vertebrae 10+14=24; no air bladder. Atlantic.

308 Helicolenus dactylopterus (De la Roche)

Redfish; Seran Imperial

Scorpaena dactyloptera De la Roche, Ann. Mus. Paris, XII, 316, 337, pl. XXII, fig. 9, 1809, Iviça, Barcelona; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 679, 1883.

Sebastes dactylopterus Günther, Cat. Fish. Brit. Mus. II, 99, 1860.

Sebastoplus dactylopterus Goode & Bean, Bull. Mus. Comp. Zool. X, no. 5, 214, 1883.

Helicolenus dactylopterus Goode & Bean, Oceanic Ichth. 249, pl. LXVIII, fig. 244, 1896; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1837, 1898.

De la Roche states that at Iviça this form is found only at considerable depths, outside of the regions commonly frequented by the fishermen; indeed, that it is very rare, or scarcely at all known, in the markets of the towns where the fishermen are not in the habit of going far out to sea. He saw many individuals taken off Iviça at a depth of 260 to 290 meters, and in the vicinity of Barcelona saw the same species from a depth of 540 meters. At Iviça the species is known as the Seran imperial, and at Barcelona as the Fanegal.

Risso saw specimens at Nice in which locality of the Mediterranean it is very common and is known as the Cardonniera. He says it grows to a length of 30 centimeters (about 1 foot) and a weight of 2 kilograms ($4\frac{2}{5}$ pounds). It is obtained on rocky bottoms at considerable depths throughout the year, and he has observed females full of eggs in summer. The species is recorded also from Naples, Genoa, Messina and Catania.

Capello states that the fish is found off Lisbon, but it is very rare and occurs only in summer. Off the coast of France, it has

been identified from Marseilles, St Jean de Luz, Biarritz, Valence, and Arcachon.

In the western Atlantic the redfish occurs in numerous localities in deep water from Narragansett bay to Chesapeake bay.

Family COTTIDAE

Sculpins

Group COTTINAE

Genus COTTUS (Artedi) Linnaeus

Fresh-water sculpins. Body fusiform. Head feebly armed; skin smooth or more or less velvety, its prickles, if present, not bony or scalelike; villiform teeth on jaws and vomer, and sometimes on palatines. Gill openings separated by a wide isthmus, over which the membranes do not form a fold; no slit behind fourth gill. Branchiostegals six. Dorsals nearly or quite separate, the first of six to nine slender spines, ventrals moderate, each with a short, concealed spine and four soft rays. Lateral line present, usually more or less chainlike, sometimes incomplete. Preopercle with a simple spine at its angle which is usually curved upward, its base more or less covered by skin, very rarely obsolete; usually two or three spines turned downward below this; subopercle usually with a concave spine turned downward. Vertebrae 10+23=33. Pyloric caeca about four. Fishes of small size, inhabiting clear waters in the northern parts of Europe, Asia and America. The species are extremely numerous and are very difficult to distinguish, all being very similar in form, coloration and habits.

The species are most destructive to the eggs of salmon and trout.

Subgenus PEGEDICTIS

309 Cottus ictalops (Rafinesque)

Miller's Thumb; Blob

Pegedictis ictalops RAFINESQUE, Ichth. Ohien. 85, 1820, spring near Lexington, Kentucky.

Cottus Richardsoni AGASSIZ, Lake Superior, 300, 1850, Montreal River; GIRARD, Monograph Fresh-Water Cottoids N. A. 39, pl. 1, figs. 1, 2, pl. 3, figs. 18–21, 1850; GÜNTHER, Cat. Fish. Brit. Mus. II, 158, 1860.

Cottus Bairdii GIRARD, Monograph Fresh-Water Cottoids N. A. 44, pl. 1, figs. 5, 6, 1850.

Uranidea richardsoni JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 696, 1883; BEAN, Fishes Penna. 136, pl. 35, fig. 74, 1893.
Cottus ictalops bairdii MEEK, Ann. N. Y. Ac. Sci. IV, 315, 1888.
Cottus ictalops MEEK, op. cit. IV, 314, 1888; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1950, 1898.

Body rather robust, gradually tapering to the tail, the depth varying from one fourth to one sixth of the length; the length of the head is contained about three and one third times in the standard length of the body; long diameter of eye almost equal to length of snout; preopercular spine short and sharp, turned upward and backward, with two smaller spines below it; skin usually smooth, sometimes with minute prickles behind axil of pectoral; spinous dorsal begins slightly behind end of head, separated from second dorsal by a deep notch; second dorsal about two and one third times longer than first, and one third longer than anal base which slightly exceeds greatest length of head; pectoral, ventral, and caudal fins well developed.

D. VI VIII, 16; A. 12-13; V. I, 4. Lateral line conspicuous, sometimes wanting on caudal peduncle.

Color olivaceous, much speckled; sides usually with several distinct and rather broad cross bands; fins barred and mottled.

Bullhead, blob and muffle-jaws are names applied to the miller's thumb, which has been associated with Richardson's name.

The typical Richardson's miller's thumb is found in the upper Great lakes. In general it inhabits the "middle and northern states, abounding in all clear, rocky brooks and lakes east of the Dakotas and Kansas to New York and Virginia, extending southward along the Alleghanies to North Carolina and northern Alabama, especially abundant in limestone springs and entering caves."

The U. S. Fish Commission had specimens from Grenadier island and Stony island, in the Lake Ontario region, collected June 28 and July 3; also from the St Lawrence river, 3 miles below Ogdensburg N. Y., July 17, taken by Dr Evermann and Mr Bean in 1894. Meek records the species from the southern

end of Cayuga lake. It is extremely variable in size, color and length of fins and number of rays.

This species grows to a length of 7 inches under favorable circumstances and is one of the most destructive enemies of the eggs and young of brook trout and other members of the salmon family.

Genus URANIDEA De Kay

This genus is very close to Cottus, from which it differs in the reduction of its ventrals to a concealed spine and three soft rays, a step further in the degeneration characteristic of fresh-water types. The skin is smooth, or very nearly so, the preopercular spines small, and there is usually no trace of teeth on the palatines. Cold streams and springs of the United States from New England and the Great lakes to the Pacific coast.

310 Uranidea gracilis (Heckel)

Miller's Thumb

Cottus gracilis HECKEL, Ann. Wien Mus. II, 148, 1837, New York; GIRARD, Monograph Fresh-Water Cottoids N. A. 49, pl. 1, figs. 11, 12, 1851; GÜNTHER, Cat. Fish. Brit. Mus. II, 157, 1860; MEEK, Ann. N. Y. Ac. Sci. IV, 315, 1888; EUGENE SMITH, Proc. Linn. Soc. N. Y. 1897, 40, 1898.

Uranidea quiescens DE KAY, N. Y. Fauna, Fishes, 61, pl. 5, fig. 14, 1842, stream and lake in Hamilton county, N. Y.

Uranidea gracilis JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 699, 1883; BEAN, Fishes Penna. 137, 1893; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. 1968, 1898.

The body is moderately slender, spindle-shaped; mouth large, the upper jaw reaching nearly to the middle of the eye. The preopercular spine is moderately large, covered by skin. The pectorals reach to the origin of the anal, and the ventrals to the vent. The depth of the body is one fifth, and the length of the head two sevenths of the total without caudal. Teeth in villiform bands on the jaws and vomer, none on the palatine bones.

D. VIII, 16; A. 12.

The sides are olivaceous, mottled with darker; a red margin on spinous dorsal.

The miller's thumb or little stargazer is an inhabitant of New England and New York. In Pennsylvania it occurs in the head-

waters of the Susquehanna and Allegheny rivers. In New York it was first taken in a stream emptying into Round lake, Hamilton county, and in Lake Pleasant, of the same county. Dr Meek examined specimens from the southern end of Cayuga lake, Beaver creek, McLean N. Y., Worcester N. Y., and Bangor N. Y., but it was not so abundant as the preceding species. Eugene Smith says that it is very plentiful in the head streams of the Hackensack and Saddle rivers in New York and New Jersey, in company with black-nosed dace and darters. This species grows to a length of 4 inches and is represented by several varieties, one of which has the body robust instead of slender and another has the slender body as in g r a c i l i s, but with longer fins.

This fish is found under stones in clear, rocky and gravelly brooks. It has no importance either as food or bait and is very destructive to the eggs of other fishes.

311 Uranidea formosa (Girard)

Lake Blob

Cottus formosus Girard, Monograph Fresh-Water Cottoids N. A. 58, 1850, Lake Ontario off Oswego, in stomach of *Lota maculosa*.

Uranidea formosa Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 955, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. 1969, 1898.

Body slender and graceful; head small, depressed above; the length of the head is contained four and one fourth times in the length of the body; eyes moderate; preopercular spine short, stout, acute, curved upwards; a small spine below it; subopercular spine well developed. Dorsals well separated; anal beginning under third ray of soft dorsal; pectorals not reaching to posterior margin of spinous dorsal; ventrals not nearly to vent.

D. VIII–16; A. II; V. 1, 3. Length 3¼ inches. Deep water in Lake Ontario.

A single mutilated specimen has been recorded, this having been found by Prof. S. F. Baird in the stomach of a Burbot (L o t a m a c u l o s a) off Oswego N. Y., in Lake Ontario.

Genus MYOXOCEPHALUS (Steller) Tilesius

Body slender or robust, subfusiform, covered with thick skin, in which are sometimes embedded prickly plates; deciduous, granular, or stellate tubercles also sometimes present, but no true scales. Head large. Mouth terminal, large, the lower jaw always included, the uppermost the longer; villiform teeth on the jaws and vomer, none on the palatines; suborbital stay strong; preopercle with two strong straight spines above directed backward, and one below directed downward and forward; opercle, nasal bones, orbital rim, and shoulder girdle more or less armed; gill membranes forming a fold across the rather narrow isthmus; slit behind last gill reduced to a mere pore, or wanting; vertebrae about 28. Branchiostegals mostly six. Dorsal fins two, separate, the first short, its spines rather slender; ventral rays 1, 3; caudal fin moderate, fan-shaped; pectoral fin broad, its lower rays procurrent. Lateral line well developed, its tubes sometimes provided with bony or cartilaginous plates, never chainlike nor reduced to separated pores. Species numerous, in the seas of northern regions; coarse fishes, little valued as food.

Subgenus ACANTHOCOTTUS Girard

312 Myoxocephalus aeneus (Mitchill)

Grubby; Brassy Sculpin; Pigmy Sculpin

Cottus æneus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 380, 1815, New York; CUVIER & VALENCIENNES, Hist. Nat. Poiss. IV, 189, 1829; DE KAY, N. Y. Fauna, Fishes, 52, 1842 (not figure); GOODE & BEAN, Bull. Essex Inst. XI, 13, 1879; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 702, 1883; BEAN, 19th Rep. Comm. Fish. N. Y. 251, 1890.

Cottus scorpio MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 380, 1815, New York.

Cottus mitchilli CUVIER & VALENCIENNES, Hist. Nat. Poiss. IV, 188, 1829, New York; DE KAY, N. Y. Fauna, Fishes, 53, pl. 17, fig. 47, 1842; GÜNTHER, Cat. Fish. Brit. Mus. II, 164, 1860.

Cottus (Acanthocottus) anceps SAUVAGE, Nouv. Archiv. Mus. Paris (2), I, 145, pl. 1, fig. 13, 1878, New York.

Acanthocottus æneus BEAN, Bull. Am. Mus. Nat. Hist. IX, 369, 1897; H. M. SMITH, Bull. U. S. F. C. 1897, 105, 1898.

Myoxocephalus æneus JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. II, 1972, 1898, pl. CCXCV, fig. 716, 716a, 1900.

Depth of body one fourth of total length without caudal. Head four elevenths of the same length, rather broad, covered with smooth thin skin; no cirri; a few very small warts between occipital ridges. Caudal peduncle short and slender, its least depth about one sixth length of head and less than diameter of eye. Maxillary three sevenths as long as head, reaching to below hind margin of pupil. Supraocular and occipital ridges prominent, each with a low, bluntish spine; the region between the supraocular spines rather convex, the space before and behind it concave; nasal spines moderate; upper preopercular spine shorter than eye, nearly twice length of next spine, about reaching middle of opercle. Eye two thirds as long as snout, one fifth as long as head. Lateral line complete, each pore with a concealed cartilaginous plate; scattered, concealed asperities on skin of sides. No trace of slit behind last gill. Dorsal base two thirds as long as head; fourth spine longest, one third as long as head. Base of soft dorsal nearly as long as head; first soft ray as long as the eye; fifth, sixth and seventh rays longest, one third as long as head. Caudal rounded, its middle rays two fifths as long as head. Anal origin under third ray of soft dorsal; anal base three fifths as long as head; longest anal ray nearly one third as long as head. Pectoral reaches to below origin of soft dorsal; ventral to below eighth spine of dorsal.

D. IX, 13; A. 10; V. I, 3; P. 15.

Grayish olive, much variegated with darker; no distinct paler spots; back and sides with broad, dark irregular bars; all the fins barred; mandible mottled; belly pale.

This little sculpin was known to Mitchill as the brazen bullhead and also to De Kay, who said it is frequently taken with the hook in Long Island Sound, and the harbor of New York. De Kay describes it again under the name of the smooth browed bullhead and states that it is commonly taken with the hook in company with the flat fishes.

The grubby seldom exceeds 5 inches in length. It ranges from the Bay of Fundy to New Jersey and is very common in seaweeds near shore. The fish has been found moderately abundant

at Fire Island in September. In Gravesend bay it is practically a permanent resident, spawning in winter; the eggs have a beautiful green color. In the vicinity of Woods Hole, Mass., according to Dr Smith, it is very common, remains during the entire year, and is the only sculpin found in summer. In winter from 10 to 50 are caught daily in fyke nets set in the harbor. The fish is then in a spawning condition, and the eggs adhere to the twine.

313 **Myoxocephalus octodecimspinosus** (Mitchill)

18-spined Sculpin; Hacklehead

Cottus octodecimspinosus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 380, 1815, New York; Cuvier & Valenciennes, Hist. Nat. Poiss. IV, 181, 1829; Günther, Cat. Fish. Brit. Mus. II, 163, 1860; Goode & Bean, Bull. Essex Inst. XI, 13, 1879; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 701, 1883; Bean, Bull. U. S. F. C. VII, 137, 1888.

Cottus virginianus De Kay, N. Y. Fauna, Fishes, 51, pl. 5, fig. 13, 1842.

Acanthocottus virginianus Storer, Hist. Fish. Mass. 28, pl. IV, fig. 2, 1867.

Acanthocottus octodecimspinosus Bean, Bull. Am. Mus. Nat. Hist. IX, 370, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 105, 1898.

Myoxocephalus octodecimspinosus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. II, 1976, 1898, pl. CCXCVI, fig. 718, 1900.

Body moderately robust anteriorly, tapering posteriorly, its depth contained four and one half times in the standard length while the least depth of the caudal peduncle is less than one sixth length of head, the length of the latter being contained two and two thirds times in the standard length; maxilla twice long diameter of eye and contained two and one half times in the length of head; the spines of the head are long, the upper opercular spine being longer than in any other species of the genus; the first dorsal originates over the base of the pectoral, its third and fourth spines being longest, about four fifths as long as the base or equal to the distance from the posterior margin of the eye to the tip of the snout; the length of the second dorsal base equals the length of the head, and the longest rays of the second dorsal equal the length of the spines; anal base shorter than second dorsal base; longest rays of anal equal to length of sixth dorsal spine; caudal slightly truncate, its length equal to the depth of body; pectorals long, broad, their bases equal to half the length; the length of the ventrals is equal to the dis-

tance from the posterior margin of the eye to the origin of first dorsal. D. IX, 16; A. 14.

General color dark olivaceous above, paler below, under side of head and belly white; fins barred and mottled.

This large sculpin reaches the length of about 1 foot. It occurs on the Atlantic coast from Virginia to Labrador and is very common about Cape Cod and in Massachusetts bay. In the southern part of its habitat it is found only in late fall and winter; in Great Egg bay, for example, an individual 12 inches long was caught at Somers Point in November. In Gravesend bay the fish is taken only in winter and early spring and it can not endure the temperature of the water in summer. It is known to the fishermen of that vicinity as the hacklehead.

De Kay does not mention any particular locality for the species, but says it ranges from Virginia to Newfoundland, and perhaps farther north. He makes the following additional remarks: "This species, which, on account of its uncouth form, is regarded with aversion by fishermen, is nevertheless not a bad article of food. In fact, when freshly taken from the water, and irritated, they do present rather a formidable appearance. The head is swollen to twice its usual size by the distension of the branchial membrane; the spines stand out prominently, and the rays of all the fins become erect. It is known under the various popular names of sculpin, *quere* scorpion? sea robin, bullhead, sea toad, and pigfish; the latter from its croaking noise when drawn from the water."

Dr Smith states that it first appears in the vicinity of Woods Hole, Mass., about October 1, becomes very abundant by October 15, and remains till December or January. The spawning time is November and December; the eggs often come ashore by bucketfuls on Nobska beach.

314 Myoxocephalus groenlandicus (Cuv. & Val.)

Daddy Sculpin

Cottus grœnlandicus Cuvier & Valenciennes, Hist. Nat. Poiss. IV, 156, 1829; Richardson, Fauna Bor.-Amer. III, 46, 297, pl. 95, fig. 2, 1836; De Kay, N. Y. Fauna, Fishes, 54, pl. 4, fig. 10, 1842; Günther, Cat. Fish. Brit. Mus. II, 161, 1860.

Cottus scorpius grænlandicus Goode & Bean, Bull. Essex Inst. XI, 13, 1879; Bean, Bull. 15, U. S. Nat. Mus. 118, 1879; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 703, 1883.
Acanthocottus variabilis Storer, Hist. Fish. Mass. 26, pl. IV, fig. 1, 1867.
Acanthocottus grænlandicus H. M. Smith, Bull. U. S. F. C. 1897, 105, 1898.
Myoxocephalus grænlandicus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. II, 1974, 1898.

The length of the body is four and one half times the depth. Head large, the length being contained two and one half times in the length of the body. Mouth large, the lower jaw included; maxillary reaching posterior edge of orbit, its length three sevenths length of head; the supraorbital and occipital spines blunt, tuberclelike, without cirrus; a small tubercular spine on front of occipital ridge; upper preopercular spine short, only reaching the middle of opercular spine, its length equaling eye, not twice that of the spine below it; opercular spine sharp; nasal spines sharp; suprascapular spine rather strong and short. Sides of body above lateral line with a series of embedded prickly plates, below which are numerous scattered spines and prickles. Dorsal and anal fins high, their hight more than one seventh total length without caudal. Ventrals long. Pectorals reaching to vent. Eye large, equal to width of interorbital space. D. X, 17; A. 14; V. I, 3; P. 18.

Dark brown above, with broad darker bars; below yellowish, the belly in the male with large pale spots; back and top of head with grayish blotches; fins brown and yellow, all of them spotted and barred. Sexual differences great, the males more brightly colored; the round white spots strongly marked; females with rough crests on the head.

The daddy sculpin is the largest of its kind on our east coast as it grows to the length of 25 inches. It ranges from New York to Greenland, but is common in New York and Massachusetts waters only in fall and winter. De Kay had met with a single specimen which was taken near Hell Gate. Storer records it as abundant on the coast of Massachusetts feeding on small fish, crabs, sea urchins and other invertebrates; but not valued as food. Dr Smith remarks that it arrives at Woods Hole in October, remains till December or January, spawning in November

and December when there is a great loss of eggs through storms. Fabricius records its spawning in Greenland in December and January and describes its eggs as red colored. The eggs, he states, are deposited on seaweed. The Greenlanders eat the fish for their daily food and they eat its eggs raw.

Genus TRIGLOPSIS Girard

Body and head slender; skin naked; lateral line chainlike; teeth on vomer, none on the palatines; eye large, the interorbital area concave; bones of lower part of head extensively cavernous; a small but distinct slit behind last gill; gill membranes almost free from the isthmus, forming a broad fold across it; preopercular spines straight, simple, 4 in number, the lower turned downward; fins large. Fresh-water fishes, closely related to Oncocottus, from which they have doubtless become degraded through fresh-water life. There is no tangible difference in structure in any part of the body.

315 Triglopsis thompsoni Girard

Lake Sculpin

Triglopsis thompsoni GIRARD, Proc. Bost. Soc. Nat. Hist. IV, 19, 1851, off Oswego, Lake Ontario; Monograph Fresh-Water Cottoids, N. A. 65, pl. 2, figs. 9, 10, pl. 3, figs. 22–25, 36–38, 1852; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 709, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. II, 2005, 1898.

Triglopsis stimpsoni HOY, Trans. Wisconsin Ac. Sci. 98, 1872, Lake Michigan.

Ptyonotus thompsonii GÜNTHER, Cat. Fish. Brit. Mus. II, 175, 1860.

Body elongate, very slender, the depth being one sixth of the length. Head long, depressed above, the length being one third of the length of the body. Snout long and pointed; eye quite large, nearly as long as snout, much wider than interorbital space, one fourth as long as the head; jaws subequal; mouth large, the maxillary extending rather beyond middle of eye; preopercle with four sharp spines, the upper much shorter than pupil; cavernous structure of skull highly developed; upper surface of head smooth; gill membranes not broadly united; nearly free from isthmus. Dorsal fins well separated; spinous dorsal short and low, its hight little more than length of snout; second

dorsal very large, three times hight of first, its longest rays about as long as head; anal high, half as high as second dorsal; pectoral long, reaching past front of anal; ventrals well developed; lateral line chainlike, conspicuous; skin perfectly smooth. Length 3 inches. D. VII 18; A. 15; V. I, 3; pyloric caeca seven.

Pale olivaceous, with darker blotches; upper fins faintly banded.

Deep waters of the Great lakes; specimens have been taken sparingly in Lakes Ontario and Michigan. The U. S. Fish Commission obtained two examples at Nine Mile Point N. Y. and on June 10, 1893, a single individual was collected at the same place. The type of the species was taken by Spencer F. Baird off Oswego, Lake Ontario. Dr William Stimpson obtained a specimen in deep water of Lake Michigan which formed the type of Dr Hoy's Triglopsis stimpsoni.

The close relationship of Triglopsis and Oncocottus has been pointed out. Both young and adults of Oncocottus have been found occasionally in fresh water and the descent of the lake sculpin from a species of Oncocottus is highly probable.

Genus HEMITRIPTERUS Cuvier

Body moderately elongate, scaleless, but the skin covered with prickles and bony protuberances of various sizes and forms. Head large, with numerous bony humps and ridges and fleshy slips above; orbital rim much elevated, the interorbital space deeply concave; a depressed area at the occiput, behind which are 2 blunt spines on each side. Mouth very wide; jaws, vomer, and palatines with broad bands of teeth; no slit behind last gill; gill membranes broadly united, free from isthmus; preopercle with stout, blunt spines; suborbital stay very strong, forming a sharp ridge. Spinous dorsal much longer than the soft part, of 16 to 18 spines, of which the first two are the highest, and the fourth and fifth shorter than the succeeding ones, the fin thus deeply emarginate; pectoral fins very broad, much procurrent; ventrals I, 3. Large fishes of singular appearance, inhabiting the North Atlantic and Pacific.

316 Hemitripterus americanus (Gmelin)

Sea Raven

Scorpæna americana GMELIN, L. Syst. Nat. 1220, 1788.

Cottus hispidus BLOCH & SCHNEIDER, Syst. Ichth. 63, 1801, New York.

Scorpæna flava MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 382, pl. II, fig. 8, 1815.

Scorpæna purpurea and *rufa* MITCHILL, Am. Month. Mag. II, 245, February 1818.

Hemitripterus acadianus STORER, Hist. Fish. Mass. 35, pl. VII, fig. 4, 1867.

Hemitripterus americanus CUVIER & VALENCIENNES, Hist. Nat. Poiss. IV, 268, pl. 84, 1829; DE KAY, N. Y. Fauna, Fishes, 56, pl. 6, fig. 16, 1842; GÜNTHER, Cat. Fish. Brit. Mus. II, 143, 1860; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 685, 1883; BEAN, 19th Rep. Comm. Fish. N. Y. 251, 1890; Bull. Am. Mus. Nat. Hist. IX, 370, 1897; H. M. SMITH, Bull. U. S. F. C. 1897, 105, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. II, 2023, 1898, pl. CCCV, fig. 738, 1900.

The length of the body is three and three fourths times the depth and two and two thirds times the length of the head. Body villous, the prickles enlarged and tuberclelike along the back and lateral line; nasal spines strong; supraocular ridge much elevated, with dermal flaps and two blunt spines; three pairs of fleshy slips on nasal bones, and two on supraocular ridges; smaller cirri on maxillary, on preorbital, and several on lower jaw; interocular space very deeply concave; two blunt occipital spines on each side, outside of which are two or three others; opercle small, with a bony ridge; preopercle with two blunt spines, below which are one or two others; lower jaw slightly projecting; maxillary reaching beyond eye, and about half as long as the head; pectorals nearly reaching anal; highest dorsal spine three fifths length of head, as long as caudal; ventrals reaching half way to anal.

D. IV, XII–I, 12; A. 13; Lat. l. 40; vertebrae 16+23.

Reddish brown, marbled with darker brown, and much variegated; yellowish below; fins variegated with light and dark. Atlantic coast of America; chiefly northward from Cape Cod.

This fish is the Acadian bullhead of Pennant and the yellow scorpaena of Mitchill. According to De Kay the name sea sculpin is sometimes applied to this species. Other names given to it are rock toadfish and deep water sculpin. It is found along the east coast from Nova Scotia to Chesapeake bay.

De Kay saw it very rarely. In Gravesend bay, specimens have been taken by John De Nyse in April, May, October, November and December.

We are indebted to Captain Lewis B. Thurber, of Patchogue, for specimens, which were taken in the fall of 1884. These were all the more remarkable for having attached to the head and back a peculiar hydroid.

In the vicinity of Woods Hole Mass. the fish is common in October and November, the individuals usually measuring about 16 inches; the young are rare. It grows to a length of 2 feet and is one of the most brightly colored of the marine fishes. Its colors are subject to great variation. The head is furnished with numerous fringes and the dorsal spines are often produced into filaments. The mouth is large, the skin rough and the belly very distensible at the will of the fish, making this species one of the curiosities of the sea. It feeds upon mollusks and all other invertebrates of suitable size.

The sea raven is not eaten, though its flesh is of excellent flavor. It is useful as a scavenger and as bait for the eel and lobster.

The sea raven spawns in November. Eggs observed Nov. 29, 1897, were in masses adhering tightly together. The egg at that date was $\frac{5}{32}$ inch in diameter, and showed the form of the fish distinctly. Its color when first deposited is yellow but soon changes to salmon and then to amber before hatching.

Family AGONIDAE

Group AGONINAE

Genus ASPIDOPHOROIDES Lacépède

Body and head more or less slender; head 4 to 6, width 5 to 8 in length of body; eight longitudinal rows of plates, the lateral line in the upper lateral row; about 40 plates in the dorsal series. Terminal rostral plate present, unarmed; mouth terminal; teeth on jaws, vomer, and palatines. Supraocular and occipital spines absent; plates of body more or less keeled, without spines. First dorsal absent; second dorsal and anal small, opposite each other, each with four to seven rays. Gill mem-

branes united, narrowly joined to isthmus anteriorly, free behind.

Subgenus ULCINA Cramer

317 Aspidophoroides monopterygius (Bloch)

Sea Poacher

Cottus monopterygius BLOCH, Ichth. II, 156, pl. 178, figs. 1, 2, 1786.

Aspidophorus monopterygius CUVIER & VALENCIENNES, Hist. Nat. Poiss. IV, 224, 1829; VI, 554, pl. 169, 1830; DE KAY, N. Y. Fauna, Fishes, 62, pl. 2, fig. 5, 1842.

Aspidophoroides monopterygius STORER, Rep. Ichth. Mass. 22, pl. 1, fig. 1, 1839; GÜNTHER, Cat. Fish. Brit. Mus. II, 216, 1860; STORER, Hist. Fish. Mass. 32, pl. VIII, fig. 1, 1867; GOODE & BEAN, Bull. Essex Inst. XI, 12, 1879; JORDAN and GILBERT, Bull. 16, U. S. Nat. Mus. 724, 1883; GOODE & BEAN, Oceanic Ichth. 283, pl. LXXII, fig. 260, 1896; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. II, 2691, 1898, pl. CCCXII, figs. 756, 756a, 1900.

Body very slender, tapering, elongate, its greatest depth nearly one twelfth of total length without caudal, its greatest width about one tenth of the same length. Head triangular, much narrowed anteriorly, its length one sixth of total without caudal; nasal spines very large, diverging, inserted near tip of snout; no other spines anywhere; eyes very large, longer than snout, one fourth as long as the head; supraocular ridges very high; a ridge extending backward from eye along temporal region; lower jaw slightly included. Caudal peduncle very long and slender, forming about two fifths of the length. Breast with flat plates. Dorsal ridges high anteriorly, the median line of back from snout to dorsal fin concave. Dorsal origin midway between hind margin of orbit and base of middle caudal rays; base of dorsal one half as long as the head and equal to length of second and longest ray. Anal immediately under dorsal and nearly equal to it in length of rays. Caudal convex behind, the middle rays two thirds as long as the head. Ventral two fifths as long as head. Pectoral reaching to eighth plate of the dorsal ridge, nearly as long as the head. Plates on breast radially striate, the two median ones larger than the rest; a few small plates on hinder median part of gill membranes, and on narrow underside of mandible; two large plates with raised centers in front of and four to eight small spineless plates in one

or two series on base of pectoral. D. 5 or 6; A. 5 or 6; P. 9; V. I, 2; C. 10 or 11; pyloric caeca four or five; lateral line about 50.

Color brownish, pale below, with indefinite cross bands of darker, two in front of, and one under dorsal, and two or three on caudal peduncle; rays of dorsal and upper rays of pectoral brownish, interrupted by lighter, giving an indefinite appearance of cross bands; caudal dark; ventrals and anal in both sexes pale.

This fish reaches a length of 6 inches; it is found in moderate depths from Greenland to Rhode Island and doubtless occurs off Long Island in suitable depths though specimens have not been recorded in New York waters. The species is very frequently obtained from the stomachs of haddock and cod, and the trawl has taken it in depths as shallow as 14 fathoms. In 1874 the head of a sea poacher was dredged up on the "Pecten Ground," off Watch Hill R. I. The fish exists in great abundance in Massachusetts bay and farther north.

Family CYCLOPTERIDAE

Lump Suckers

Group CYCLOPTERINAE

Genus CYCLOPTERUS (Artedi) Linnaeus

Body more or less compressed toward the back, somewhat triangular in a transverse section at the first dorsal, covered with conical, rough, bony tubercles; head short, thick, subquadrangular in a cross section; snout blunt, rounded; mouth anterior, opening slightly upward; teeth simple, small, arranged in a band; eye moderate, lateral; dorsals two; caudal distinct; disk moderately large, anterior, below the head; no barbels about the mouth; first dorsal fin in the adult completely hidden by the skin, the larger tubercles of the flanks, though in regular series, having a scattered appearance. One species, reaching a considerable size, in the north Atlantic.

318 Cyclopterus lumpus Linnaeus

Lumpfish; Lumpsucker

Cyclopterus coeruleus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I. 480, pl. II, fig. 7, 1815, New York Harbor.

Lumpus anglorum DE KAY, N. Y. Fauna, Fishes, 305, pl. 54, fig. 175, 1842; STORER, Hist. Fish. Mass. 208, pl. XXXII, fig. 2, 1867.

Cyclopterus lumpus LINNAEUS, Syst. Nat. ed. X, I, 260, 1758; GÜNTHER, Cat. Fish. Brit. Mus. III, 155, 1861; GOODE & BEAN, Bull. Essex Inst. XI, 11, 1879; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 747, 1883; BEAN, Bull. Am. Mus. Nat. Hist. IX, 370, 1897; H. M. SMITH, Bull. U. S. F. C. 1897, 105, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. II, 2096, 1898, pl. CCCXIII, fig. 757, 1900.

Body massive, compressed, subtriangular in transverse section through the middle, belly flattened, the portion behind the abdominal chamber much compressed, and less than one half the length of the body proper; greatest depth of body one half or more than one half of total length including caudal. Caudal peduncle short, its least depth one third length of head. Head short, subquadrangular in transverse section, forehead broad, flattened; length of head one fourth of total length with caudal. Nape high. Snout short, broad, blunt, one fourth as long as the head. Mouth wide, terminal, oblique, the maxillary reaching to below the front margin of the orbit. Eye lateral, placed high, as long as the snout, and one third as wide as interorbital space. Nostrils small, the hinder smaller, near the eyes on interorbital space, the anterior farther forward, halfway to the mouth, with a short tube. Gill opening moderately wide, about three fifths length of head, its lower third in front of base of pectoral. Fins with rounded margins, rough, with small tubercles. First dorsal distinct in very young individuals, variable in shape, thick and fleshy, with weak rays in older stages; second dorsal always distinct, broad, rounded, its origin two and one half times as far from tip of snout as from base of middle caudal rays, its longest ray one half as long as head. Caudal broad, subtruncate or rounded behind, its middle rays one half as long as the head. Anal exactly opposite the dorsal and about equal in size. Pectoral broad, rounded, fringed, not indented at the sides of the disk, its length one sixth of the total without caudal. Disk little longer than wide, about as wide, or nearly three fourths as long, as the head. Skin thickly covered with small, irregular subconical tubercles, the sides of which are roughened with small, conical protuberances. On older individuals, larger, longitudinally compressed tubercles form a vertical series from the nape over the first dorsal; a series of three tubercles at

each side of the space between the dorsals; a row of larger ones extends from the supraorbital region along the flank to the upper part of the tail; a series, starting a little above the pectoral, passes to the lower portion of the tail; and a third lateral series reaches along each line of the lower surface from the side of the disk to the anal. The fleshy ridge enveloping the first dorsal is subject to considerable variation; it usually continues forward on the nape and becomes indefinite at the occiput. D. VI to VIII, 11; A. 9 or 10; V. 6; P. 20; C. 12 to 14; B. 6; vertebrae 11+18=29.

Colors in alcohol, brownish or olive to grayish, the tubercles darker. In life the tints vary from yellowish or greenish in the young to more or less brilliant red in males, or bluish to dark brown in females; spots, blotches, cloudings, or other markings are not infrequent. The young often take the color of their surroundings. De Kay had a specimen with the following colors: above deep blue, becoming paler on the sides, which are tinged with yellowish beneath, approaching to red. Ventrals bright yellow, and in the spawning season, bright red. Irides yellowish. Kumlien had one with iris umber.

The lumpfish is called cock-paddle and hen-paddle in Scotland, lumpsucker, lumpfish, and sea owl in England, Licorne de Mer in France. Its habitat is in the North Atlantic, on rocky shores of both coasts, south to New York and France. It is said to attain to a weight of 17 pounds and a length of 20 inches, but is usually much smaller. The species is rarely used for food in our country, but in Scotland it is said to be considered a great delicacy.

By means of its ventral disk it can adhere firmly to any solid substance. Pennant relates that upon throwing one of these fishes into a pail of water it adhered so strongly that upon taking hold of the fish by the tail he lifted the whole vessel containing several gallons of water.

The lumpfish is found in Gravesend bay in May. It will not live longer than a few weeks in captivity. Adults are common in the vicinity of Woods Hole Mass. in April and a few are seen

in May. The young are very common throughout the summer in Vineyard Sound among driftweed. Spawning occurs in April, sometimes in March, near the shore. After spawning the female retires to deep water and the male guards the eggs which hatch among seaweed.

Family LIPARIDIDAE

Sea Snails

Group LIPARIDINAE

Genus NEOLIPARIS Steindachner

This genus differs from Liparis in having a deep notch in the dorsal fin anteriorly, separating the spines from the soft rays. The species approach more nearly to the cottoid type, from which the liparids are descended. In general the vertebrae are fewer, the fin rays fewer, the ventral disk larger, and the vertical fins better separated than in the more degenerate members of the family. The retention of the notch between the dorsals fully justifies the recognition of Neoliparis as a distinct genus.

319 Neoliparis atlanticus Jordan & Evermann

Sea Snail; Lumpsucker

Liparis montagui CUVIER, Règne Anim. ed. 1, vol. 2, 227, 1817; JORDAN & GILBERT, 743, 1883, in part; GARMAN, Discoboli, 47, 1892, with plate.
Liparis Montagui PUTNAM, Proc. Am. Assoc. Adv. Sci. 335, 1874; GOODE & BEAN, Bull. Essex Inst. XI, 12, 1879.
Neoliparis montagui H. M. SMITH, Bull. U. S. F. C. 1897, 105, 1898.
Neoliparis atlanticus JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. II, 2107, 1898.

Body widest at gill opening, compressed posteriorly, deepest below third dorsal spine, its depth two ninths to one fourth of the total length without caudal. Head broader than deep, depressed above the eyes, its length contained four and two thirds times in total without caudal; snout one third and eye one fifth as long as the head. Mouth narrow, its cleft transverse and extending to anterior nostril; lower jaw included; teeth tricuspid, the middle cusps highest; gill openings very narrow, the lower border opposite first ray of pectoral; anterior nostril tubular, the tube three fifths as long as the eye; posterior nostril with a low flap; skin loose, lying in folds. Origin of dorsal not far behind pectoral, its distance from tip of snout one third its

distance to base of caudal. Dorsal with a very shallow notch, the spines nearly continuous with the soft rays; in the males much elevated, the tips thickened and membranes deeply incised; the first or longest spine as long as head; the sixth or last not quite one half as long as head; middle rays of soft dorsal one half as long as head; dorsal and anal joined to base of caudal; caudal nearly as long as head; pectoral almost reaching anal, slightly longer than head; lower rays exserted, forming a slight lobe. Ventral disk one half to four sevenths as long as the head.

D. VI, 25; A. 23; P. 30.

Color reddish brown, with small scattered light or bluish dots over the body; fins darker, clouded with pale, the dorsal broadly edged with darker. Described from a specimen about 5 inches long, from Godbout, Quebec, and from other specimens collected at Salem Mass., and Woods Hole Mass. (After Jordan and Evermann)

The sea snail is generally common along rocky shores from Newfoundland to Connecticut. At Woods Hole it is not common in the shallow waters near the shores. In Massachusetts bay it is a resident of rocky bottoms among the roots of the Kelp (Laminaria saccharina), but is less frequently taken than the striped lumpsucker. Putnam recorded specimens from Salem and Nahant. The species reaches a length of about 5 inches.

Genus LIPARIS (Artedi) Scopoli.

Body rather elongate, covered with smooth skin, which is usually freely movable; head short, flattened above; mouth horizontal, the jaws equal or the lower jaw included; teeth in several series, close set, always more or less tricuspid, the adult with the outer cusps often worn or obliterated; maxillary covered by skin of preorbital region; anterior nostrils tubular or not; ventral disk well developed on the breast, its front below or behind the middle of the head, its surface with 13 lobes; an anterior median lobe, and one corresponding to each of the six rays in the fin; each lobe with a horny papilla covering, which is sometimes lost; vent well behind the head, about midway

between the sucking disk and anal fin; dorsal fin continuous, undivided, its spines not differentiated; caudal well developed; dorsal fin free from caudal or joined; pectoral broad, procurrent at base, emarginate and free at tips, some of the lower rays produced; vertical fins enveloped in the lax skin; vertebrae 35 to 55. Northern seas, near the shores; the species less arctic in distribution and, in general, inhabiting shallower water than is the case with Careproctus and Paraliparis, a fact associated with the reduced number of vertebrae in Liparis. The species are numerous, but in general well defined, their characters varying with age. In most of the species color varieties occur, several having the body often marked everywhere with concentric curved stripes or rings.

Subgenus LIPARIS (Artedi) Scopoli

320 Liparis liparis (Linnaeus)

Sea Snail; Striped Sea Snail

Cyclopterus liparis Linnaeus, Syst. Nat. ed. XII, I, 414, 1766, Northern Ocean.

Liparis vulgaris Fleming, Brit. Anim. 190, 1828; Günther, Cat. Fish. Brit. Mus. III, 159, 1861; Goode & Bean, Bull. Essex Inst. XI, 12, 1879; Bean, Bull. 15, U. S. Nat. Mus. 115, 1879.

Liparis lineata Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 742, 1883.

Liparis liparis Cuvier, Règne Anim. ed. 1, vol. 2, 227, 1817; Garman, Discoboli, 57, 1892; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. II, 2116, 1898; H. M. Smith, Bull. U. S. F. C. 1897, 105, 1898.

Body thick and subcylindric anteriorly, compressed posteriorly, enveloped in an unctuous, thin, loose skin; its greatest depth about one fifth of the total length. Head obtuse, one fourth of total length; nape slightly swollen. Snout broad, not depressed, moderately long. Cleft of mouth horizontal, not reaching vertical from front of eye; lips rather thick; upper jaw longer than lower. Both jaws with a band of villiform teeth, becoming cardlike in very large individuals. Eye lateral, but interfering with the upper profile of head, one seventh as long as head, one half as long as snout and one half of width of interorbital space. Nostril close before eye. Gill opening reduced to a vertical slit extending downward on upper part of base of pectoral, the remainder of the gill membranes being united with

the base of the pectorals and with the isthmus. Gills $3\frac{1}{2}$; pseudobranchiae not evident. Pectoral very broad, extending downward and forward under the throat; the twelve upper rays reach to the vertical from the origin of the anal, the remainder gradually becoming shorter as far as the last but six, which are considerably produced. The six rays which constitute the base of the ventral disk may be easily distinguished; the disk is surrounded by about 13 soft and flat papillae. Dorsal fin commencing above middle of pectoral and slightly connected with caudal; its middle rays highest. Caudal moderately long and rounded, its rays simple, articulated. Anal origin below seventh ray of dorsal, the fin continuous with the caudal. Vent midway between ventral disk and anal fin.

B. 6; 33 to 36; A. 27 to 29; P. 34 to 37; C. 10 to 14; pyloric caeca 10 to 16; vertebrae 38 to 42.

Color very variable. Some specimens are pale yellowish brown, mottled and spotted with dark brown. Others are reddish gray, with broad, irregular black spots; fins reddish, with black dots arranged in transverse bands. Others, again, are brownish, with irregular darker longitudinal streaks on the head and body. (After Günther)

The species grows to the length of 5 inches. It inhabits the North Atlantic, on both coasts, extending southward to Long Island Sound and France.

At Woods Hole Mass., according to Dr Smith, it is common in winter on rocky bottoms, and is found full of spawn in December and January. In Massachusetts bay it is a resident of rocky bottoms among the roots of the kelp. Mr J. H. Sears discovered it in the vicinity of Salem, near Baker's island, in 6 feet of water. Kumlien found it fastened to kelp in Cumberland gulf in depths of 5 to 7 fathoms. It is to be noted that Kumlien's specimens had an increased number of rays in the dorsal and anal fins.

Richardson mentions this sea snail from the west side of Davis strait, in lat. 70° n. and from Regent's inlet.

Professor Collett found the alimentary canal of one specimen filled with small amphipods, one of them being Caprella

septentrionalis, together with many individuals of Protomedeia fasciata. Dr Günther found the stomach of a large specimen filled with shrimp.

Group GOBIOIDEI

(*Gobies*)

Family GOBIIDAE

Subfamily GOBIINAE

Genus GOBIOSOMA Girard

Body entirely naked; mouth moderate, horizontal; snout blunt; teeth in several series, the outer row enlarged; no canines; dorsal spines normally seven, rarely five or six; second dorsal and anal short; no barbels about head; shoulder girdle without flaps. Species chiefly American.

321 Gobiosoma bosci (Lacépède)

Naked Goby; Mud Creeper; Oysterfish

Gobius bosci LACÉPÈDE, Hist. Nat. Poiss. II, 555, pl. 16, fig. 1, 1798. Charleston, S. C.

Gobius alepidotus BLOCH & SCHNEIDER, Syst. Ichth. 547, 1801; DE KAY, N. Y. Fauna, Fishes, 160, pl. 23, fig. 70, 1842. New York Harbor.

Gobius viridipallidus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 379, pl. 1, fig. 8, 1815.

Gobiosoma alepidotum GÜNTHER, Cat. Fish. Brit. Mus. III, 85, 1861; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 638, 1883.

Gobiosoma bosci JORDAN & GILBERT, Proc. U. S. Nat. Mus. 613, 1882; BEAN, Bull. U. S. F. C. VII, 136, 1888; 19th Rep. Comm. Fish. N. Y. 249, 1890; Bull. Am. Mus. Nat. Hist. IX, 370, 1897; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2259, 1898; H. M. SMITH, Bull. U. S. F. C. 1897, 105, 1898; BEAN, 52d Ann. Rep. N. Y. State Mus. 109, 1900.

Body moderately elongate, its depth one fifth or one sixth of total length without caudal; head very broad, three tenths of total length without caudal, flattish above, with tumid cheeks. Eye small, longer than snout, one fifth as long as the head. Mouth large, little oblique, the jaws subequal, the maxillary, at least in males, extending to below posterior part of orbit, three sevenths as long as head. Teeth in few series, the outer considerably enlarged; two teeth on each side of inner series of lower jaw specially large canines. Dorsal spines slender, not filamentous. Caudal rounded. D. VII, 14; A. 10.

Olivaceous or grayish, with darker cross shades of rounded spots; seven or eight paler transverse bars over the body and tail; fins dark brown, with a bluish shade. De Kay says the body is greenish brown, with seven vertical dusky bands, and the caudal fin with two or three curved bars.

The naked goby, or mud creeper, is found on the Atlantic coast from Cape Cod to Florida.

This is the variegated goby of Drs Mitchill and De Kay. Dr Mitchill described it as Gobius viridi-pallidus. He had specimens 2½ inches long from the bay of New York, and illustrates one of them in fig. 8, pl. I, of his *Fishes of New York*.

The ventral fins of this little fish form a sucking disk of comparatively great power, as may be appreciated from the following sentence of Dr Mitchill: "One of the individuals now lying before me adhered so firmly to a stone that he was lifted out of the water by an oysterman." The variegated goby does not exceed 2½ inches in length, and is now known from Buzzard's bay southward, its southern limit being undetermined. In the Gulf of Mexico occurs a form which was set apart as a distinct species by Girard, but this may be merely a color variety. The fish has no economic value. Its name in Great South bay is mudcreeper. Numerous examples were found at the mouth of Swan creek and in Blue Point cove. Several were obtained also at Fire Island. All of these were secured late in September.

In 1901, the young, measuring from ½ inch to 1½ inches, were taken in Swan river, August 8, and on September 14 some large individuals were secured in empty oyster shells off Duncan's creek. Numerous specimens were caught in eel pots off Swan river and off Widow's creek, and the species was obtained once in fresh water in Swan river.

Taken in moderate numbers in oyster dredges at Eaton's Neck Long Island, in the fall of 1896. Several individuals lived all winter in a balanced tank, and took food greedily, but on the approach of summer all died.

On August 13, August 30, and September 16, 1887, the writer seined a few examples at Somers Point and Ocean City N. J.

At the latter place they were associated with Fundulus, Cyprinodon, Lucania, Mugil, Bairdiella, Anguilla, and swarms of shrimp.

This little goby seizes its food with a snap, and immediately darts off to conceal itself in a rock crevice or behind plants.

Group TRACHINOIDEI

Trachinoid fishes

Family URANOSCOPIDAE

Stargazers

Subfamily URANOSCOPINAE

Genus ASTROSCOPUS Brevoort

Body robust. Head above not entirely covered with bone, the occipital plate ceasing much behind the orbits; from the middle line anteriorly a Y-shaped bony process extends forward, the tips of the fork between the eyes; a trapezoidal space on either side of the Y, covered by naked skin, bounded by the Y, the eyes, the suborbitals, and the occipital plate. A covered furrow behind and on the inner side of each eye terminating near front of orbits, its edges fringed. Head without spines; humeral spine obsolete; lips and nostrils fringed; no retractile tentacle in mouth. Young individuals with top of head largely covered by bone. Head scaleless; back and sides covered with close set scales; belly mostly naked. No spine before the ventrals. First dorsal small, of four or five low, stout, pungent spines, connected by membrane to the second dorsal which is rather high and long; pectorals and ventrals large. Species American, distinguished from the Old World genus, Uranoscopus, chiefly by the unarmed head.

322 Astroscopus guttatus Abbott

Spotted Stargazer

Astroscopus guttatus ABBOTT, Proc. Ac. Nat. Sci. Phila. 365, 1860, Cape May, N. J.; BEAN, Bull. Am. Mus. Nat. Hist. IX, 370, 1897; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2310, 1898.

Upsilonphorus guttatus BEAN, Proc. U. S. Nat. Mus. 60, 1879; KIRSCH, Proc. Ac. Nat. Sci. Phila. 264, 1889.

Astroscopus anoplus BEAN, Bull. U. S. F. C. VII, 136, pl. I, figs. 1, 2, 1888, Somers Point, N. J., not *Uranoscopus anoplos* C. & V.

Depth of body contained four times in its length in the young, three and one fourth times in the adult. Eye small, its diameter contained five and one half times in interorbital space. Naked space between forks of Y on top of head short and broad, but longer than the vertical limb of the Y, which is very short. Two distinct spinules directed forward before eye; white spots on body very small and irregular, without dark rings; base of dorsals equaling in length the distance from front of first dorsal to tip of snout; base of first dorsal twice length of its longest spine; first spine equaling second in length, and three times length of last. Middle caudal rays a little shorter than ventral fin. Pectoral slightly longer than ventral, two sevenths of total length to caudal base, and extending to fifth anal ray.

D. IV or V, 13 or 14; A. 13; V. I, 5.

Color of upper parts of body and lower jaw bright chocolate; belly and throat white; darker portions covered with numerous circular spots much lighter than ground color; membrane of first dorsal black; second dorsal white with three irregular bands of dull black obliquely across it; the caudal with three parallel bands of blackish brown, the middle of which appears to be the continuation of a variable longitudinal band on the center of each side; the anal having a variable band of dull brown, darker upon the posterior termination.

If the young stargazer identified as Astroscopus anoplus by the writer in his paper on the *Fishes of the Great Egg Harbor Bay*, be identical with the A. guttatus of Abbott, the following notes will be of interest in connection with the species under discussion:

A single young individual, 1 inch long, was seined at Ocean City, August 1. The species has not previously been recorded from this bay.

Another example, 2½ inches long, was caught at Longport, August 26, not far from the inlet. The colors of the specimen, August 28, are as follows: Top of head, cheeks, sides, and a narrow strip along dorsal bases, plum color; back, olive; lower part of head, belly, ventrals, anal, and soft dorsal, whitish; caudal,

pale, with a faint yellow blotch at base and a dusky streak on middle portions; spinous dorsal, black; chin with a yellow T-shaped marking, the stem of the T bounded on each side by a wing-shaped blotch of purple, which has a dark inner edge; pectoral, plum color, its lower margin whitish. D. IV, 14; A. 13. A prominent anal papilla. A low fold of skin extends from the ventrals along the median line of the belly to the anal papilla. Two slight furrows between the eyes, with two rows of papillae along their inner margins. Behind these furrows are naked spaces, little developed, but quite distinct. Nostrils surrounded by a row of papillae.

The same stargazer was caught in Gravesend bay Oct. 24, 1894. It lived about a month in captivity and then was killed by the low temperature of the water.

This stargazer inhabits the Atlantic coast of the United States from Long Island to Virginia, but is nowhere plentiful. It has been recorded from Gravesend bay, N. Y., Tompkinsville N. Y., Somers Point N. J., Cape May N. J. and Norfolk Va. The species attains to the length of 12 inches. The changes through which the fish passes from youth to adult age are rather remarkable.

Family BATRACHOIDIDAE

Toadfishes

Genus **OPSANUS** Rafinesque

Body comparatively short and robust, scaleless; head large, depressed; jaws, vomer, and palatines each with a single series of strong blunt teeth; mandible with an additional external series at symphysis; teeth of upper jaw small; dentary bones forming an acute angle at symphysis; lips fleshy; upper angle of opercle with two diverging spines, more or less concealed in the skin; no poison glands; spinous dorsal of three stout, short spines, the second the longest; axil of pectoral with a large foramen; lateral line obscure, its pores not conspicuous; young with a series of small, tufted cirri on back and sides; branchiostegals six; vertebrae 12+22. Shore fishes, mostly of temperate regions; voracious creatures, living on the bottoms, feeding on mollusks and crustacea, and having great strength of jaw.

323 Opsanus tau (Linnaeus)

Toadfish; Oysterfish

Gadus tau Linnaeus, Syst. Nat. ed. XII, I, 440, 1766, Carolina.

Lophius bufo Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 463, 1815, New York.

Batrachus celatus De Kay, N. Y. Fauna, Fishes, 170, pl. 50, fig. 161, 1842, New York.

Batrachus tau Cuvier & Valenciennes, Hist. Nat. Poiss. XII, 478, 1837; De Kay, N. Y. Fauna, Fishes, 168, pl. 28, fig. 86, 1842; Günther, Cat. Fish. Brit. Mus. III, 167, 1861; Storer, Hist. Fish. Mass. 105, pl. XIX, figs. 1, 2, 1867; Goode & Bean, Bull. Essex Inst. XI, 11, 1879; Bean, Bull. U. S. F. C. VII, 135, 1888; 19th Rep. Comm. Fish. N. Y. 249, 1890.

Body robust, naked, its depth about one fourth of the standard length; depth of caudal peduncle one fourth length of head; head broad, its length about one third that of the body with head; mouth large; jaws strong, armed with blunt teeth; well developed teeth on vomer; long diameter of eye one third length of mandible; a broad flap above orbit; tip of maxillary, lower side of mandible, and margin of preopercle fringed with cirri; subopercle ending in a sharp spine; first dorsal small, placed over base of pectorals; second dorsal long, its base about one half of total length without caudal; pectorals broad, the width of their base equaling one half length of head.

D. III, 26–28; A. 24.

Color dark olive; under parts lighter; black markings on sides forming irregular bars; many pale or yellowish spots on body; soft dorsal, anal, pectoral, and caudal fins with light cross bands formed of light colored spots.

In some parts of the south this species is known as the oysterfish, from its habit of living in dead oyster shells. The toadfish ranges on our east coast from Cape Cod to the Gulf of Mexico. The fish is said to grow to the length of 15 inches. It is a voracious species, feeding upon other fishes, and upon shellfish, crabs and other crustacea, annelids, etc.

On rocky bottoms it occurs under stones, and on sandy and muddy areas it frequents localities abounding in eelgrass. The toadfish lies in concealment for its prey, and darts out quickly to effect a capture. Its breeding season is during the summer

months. The habits are fully described by Storer in the *Fishes of Massachusetts*. The eggs adhere to stones in shallow water. By the end of August the young have reached a length of about one inch. The nest and young are guarded by the parent fish. The species is not an attractive one, and though the flesh is sweet and palatable it is rarely eaten. To the fishermen this is one of the worst nuisances in our waters, since it is always ready to take the hook and swallow the bait intended for more useful fish. In Great South bay the toadfish was taken at the mouth of Swan creek and in Blue Point cove late in September. Young individuals were collected September 10 at the Blue Point Life-saving station.

In 1898 the toadfish was again found abundantly in Great South bay in August and September. They are distributed in all portions of the bay, except where the water is nearly fresh. In 1901 the eggs were found upon the point of hatching in the middle of July and in the month of August. On July 16, a lot of embryos measuring from $\frac{3}{16}$ to $\frac{11}{16}$ of an inch were obtained. The eggs adhere firmly to the bark of stakes, or the undersurface of sunken wood, stones, or any other heavy substance which will answer the purpose of concealment.

The toadfish is not present in Gravesend bay in the hot summer months. Most of the individuals taken were caught in August, September and October. It is possible to keep it in captivity during the summer months by careful management.

Group BLENNIOIDEI
Blennylike Fishes

Family BLENNIIDAE
Blennies

Genus BLENNIUS (Artedi) Linnaeus

Body oblong, compressed, naked; head short, the profile usually bluntly rounded; mouth small, horizontal, with a single series of long, slender, curved, close set teeth in each jaw, besides which, in the lower jaw at least, is a rather short and stout fanglike canine tooth on each side; premaxillaries not protractile; gill openings wide, extending forward below, the

membranes free from the isthmus, or at least forming a broad fold across it. Dorsal fin entire, or more or less emarginate, the spines slender; pectorals moderate; ventrals well developed, I, 3; no pyloric caeca; lateral line developed anteriorly. Species numerous, lurking under rocks and algae in most warm seas; some species in the lakes of northern Italy. The European species in general are larger in size than ours, with higher fins.

324 Blennius fucorum (Cuv. & Val.)

Seaweed Blenny

Blennius fucorum Cuvier & Valenciennes, Hist. Nat. Poiss. XI, 263, pl. 324, 1836, 240 miles south of Azores; De Kay, N. Y. Fauna, Fishes, 149, pl. 22, fig. 66, 1842, in seaweed, not far from New York coast; Günther, Cat. Fish. Brit. Mus. III, 217, 1861; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 759, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2379, 1898.

Blennius oceanicus Cuvier & Valenciennes, op. cit. 265, 1836, open Atlantic, 29° N., 50° W.

The length of the body is five times the length of the head; orbital cirri nearly as long as head, bifid above, and with fringes at the base; dorsal fin slightly emarginate, free from the caudal, the spines rather stiff. Head very short and deep, its profile nearly vertical; 24 teeth in each jaw; both jaws with very strong canines. Gill membranes free from isthmus posteriorly. Eyes very large, one third as long as head. D. XI, 17; A. 18.

Color olive green, becoming darker above, with numerous brown spots on cheeks and sides of body; below faintly reddish; dorsal with a large black spot in front, behind which are some smaller spots; spinous dorsal edged with paler.

The seaweed blenny was obtained by De Kay in a voyage from Constantinople to New York in 1831. He met the species swimming about seaweed not far from the coast of New York and made notes of it at the time, considering it as either a young individual of some larger species or undescribed. This specimen was not more than 1½ inches long. The type of the species was taken south of the Azores. The coloration as stated by De Kay is as follows: "Soiled greenish, changing to brownish above, with numerous brown spots on the cheeks and side of the body;

throat and belly faintly rosaceous; iris bluish with reddish points radiating about the pupils."

The largest specimen recorded is $2\frac{1}{2}$ inches long.

Genus CHASMODES Cuv. & Val.

Body oblong, compressed, naked; head triangular in profile, the snout somewhat pointed; mouth large, with lateral cleft, the maxillary usually, but not always, extending to beyond eye; premaxillaries not protractile; teeth in a single series, long and slender, comblike, confined to the front of each jaw; no canines; cirri very small or wanting; gill openings very small, their lower edge above the middle of the base of the pectorals; lateral line incomplete. Fins as in Blennius. American. The species with smaller mouth approach Hypsoblennius, which genus is not far separated from Chasmodes.

325 Chasmodes bosquianus (Lacépède)

Banded Blenny

Blennius bosquianus LACEPEDE, Hist. Nat. Poiss. II, 493, pl. 13, fig. 1, 1800. South Carolina.

Blennius pholis MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 374, 1815.

Chasmodes boscianus GÜNTHER, Cat. Fish. Brit. Mus. III, 229, 1861.

Chasmodes bosquianus CUVIER & VALENCIENNES, Hist. Nat. Poiss. XI, 295, pl. 327, 1836; DE KAY, N. Y. Fauna, Fishes, 151, pl. 24, fig. 73, 1842. New York Harbor; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 756, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2394, 1898.

The depth of the body is contained three and one half times in its length which is three and one half times the length of the head. Orbital tentacle very minute or wanting; maxillary extending to rather beyond eye; interocular space very narrow, not concave. Dorsal fin not emarginate, the spines slender. Dorsal joined to base of caudal; anal free. D. XI, 19; A. 20.

Color (in ♂) olive green, with about nine horizontal narrow blue lines, these somewhat irregular and interrupted, converging backwards; opercular membrane and a broad stripe through middle of spinal dorsal deep orange yellow; anal fin dark, the rays with white membranaceous tips; ♀ dark olive green, reticulated with narrow pale green lines, and with several broad dark bars, which are more distinct posteriorly; vertical fins

similarly marked; head finely dotted with black; a dusky spot at base of caudal in both sexes. New York to Florida.

Mitchill found a specimen of this little blenny in an oyster, and described it under the name Blennius pholis. Another specimen was sent to Cuvier from New York, and a specimen in the Lyceum in New York, described by De Kay, was obtained from New York harbor. This blenny is common southward in shallow water. It seldom exceeds the length of 3½ inches.

Family XIPHIDIIDAE

Rock Eels

Genus PHOLIS (Gronow) Scopoli

Body long and low, considerably compressed, somewhat band-shaped, the tail slowly tapering; head small, compressed, naked; mouth rather small, oblique; jaws with rather small teeth in narrow bands or single series; vomer and palatines usually toothless; gill membranes broadly united, free from the isthmus; scales very small, smooth; no lateral line. Dorsal fin long and low, beginning near the head, composed entirely of stiff, sharp, subequal spines; anal similar in form, of two spines and many soft rays; caudal fin short and small, more or less joined to dorsal and anal; pectorals short, rather shorter than head; ventrals very small, of one spine and a rudimentary ray; intestinal canal short, without caeca. Shore fishes of the Northern seas.

326 Pholis gunnellus (Linnaeus)

Butterfish; Rock Eel

Blennius gunnellus Linnaeus, Syst. Nat. ed. X, I, 257, 1758, Atlantic Ocean.

Centronotus gunnellus Bloch & Schneider, Syst. Ichth. 167, 1801; Günther, Cat. Fish. Brit. Mus. III, 285, 1861.

Ophidium mucronatum Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 249, pl. 2, fig. 1, 1815.

Gunnellus mucronatus De Kay, N. Y. Fauna, Fishes, 153, pl. 12, fig. 36, 1842, New York Harbor; Storer, Hist. Fish. Mass. 94, pl. XVII, fig. 2, 1867.

Muraenoides gunnellus Goode & Bean, Bull. Essex Inst. XI, 11, 1879.

Pholis gunnellus Bean, Bull. Am. Mus. Nat. Hist. IX, 370, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 106, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2419, pl. CCCXLII, fig. 832, 1900.

Body much compressed, elongate, its greatest depth equal to length of head and one eighth to one seventh of the total length without the caudal. Eye small, twice width of interorbital space, and one fifth length of head. Maxillary one third as long as head, reaching to below front of orbit. Teeth blunt, in a single row, not close set. Origin of dorsal immediately over the gill opening; the longest spine as long as the snout; the fin separated from the caudal by a slight notch. Pectoral about one half as long as head, reaching to below sixth spine of dorsal. Ventral minute. D. LXXVI to LXXXV; A. II, 38 to 44; V. I, 1; P. 12.

Color grayish or brownish, with a series of oval vertical dusky rings on the sides; abdomen grayish white, tinged with yellow; dorsal fin gray, with about 14 black vertical distant stripes; pectorals and caudal yellow; anal fin greenish gray, with alternate darker stripes; iris white.

This fish reaches the length of 12 inches. It is found in the North Atlantic from Labrador south to Cape Cod and from Norway south to France.

Dr Smith states that this rock eel or butterfish is abundant around the shores in the vicinity of Woods Hole Mass. in March and April, but is rare at other times. It may be taken in Vineyard Sound with a dredge at almost any season at a depth of 4 or 5 fathoms. It occurs only on gravelly bottoms.

The only individuals collected by myself were taken on the oyster beds at Eaton's Neck in the fall of 1896. The species does not live long in captivity.

On June 6, 1899, Captain H. E. Swezey obtained a few specimens of this species on the ocean beach at Water Island. Mitchill described the rock eel or butterfish (Ophidium mucronatum) in Trans. Lit. & Phil. Soc. N. Y., I, 249, pl. II, fig. 1. De Kay says this fish "is frequently found among rocks along the seashore and in the mud. It swims with great rapidity although its usual habit is that of creeping slowly among rocks, in which it is probably assisted by its spiny ventrals. It abounds in Robyn's reef, in the harbor of New York."

Subfamily STICHAEINAE

Genus ULVARIA Jordan & Evermann

This genus is very close to Eumesogrammus, from which it differs in the absence of the lowermost or third lateral line, the median line being bifurcate.

327 Ulvaria subbifurcata (Storer)

Radiated Shanny

Pholis subbifurcatus STORER, Rep. Fish. Mass. 63, 1839, Nahant, Mass.; Hist. Fish. Mass. 92, 1867; DE KAY, N. Y. Fauna, Fishes, 150, 1842.

Eumesogrammus subbifurcatus GOODE & BEAN, Bull. Essex Inst. XI, 10, 1879; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 775, 1883.

Ulvaria subbifurcata JORDAN & EVERMANN, Check-List Fish. N. & M. A. 475, 1896; Bull. 47, U. S. Nat. Mus. III, 2440, 1898, pl. CCCXLV, fig. 842.

Body moderately compressed, fusiform, its greatest depth about one fifth of the length without caudal. Head moderately large, nearly one fourth of total length without caudal; mouth large, the maxillary extending to below the middle of the eye, the jaws equal in front; eye large, a little longer than the snout, one fourth as long as the head. Dorsal origin at a distance from tip of snout equal to length of head; longest spines about in the middle of the fin two fifths as long as the head; first spine two thirds as long as the eye. Caudal rounded, its middle rays one half as long as the head. Anal origin under the 14th spine of the dorsal, the fin not extending to the caudal, its longest ray one third as long as the head. Pectoral extending slightly past the vertical from the ninth spine of the dorsal, its length one sixth of total without caudal. Ventral in advance of dorsal origin, three eighths as long as head. Back somewhat arched; ventral outline nearly straight. Median lateral line forked over the pectoral, the upper branch extending about as far back as the extended pectoral. Scales very small.

D. XLIV; A. 28 to 30; V. I, 3; P. 14.

"Color, above reddish brown. Opercle and preopercle yellowish. Light colored circular patches along the base of the dorsal fin; beneath the lateral line lighter. Abdomen yellowish

white. From beneath the eye, a broad black band, which is widest at its origin, crosses the opercle obliquely; two other bands of the same color extend from behind the eye backward, in nearly a straight line, to a distance of from one to two lines. Numerous black spots on the dorsal fin [one of these extending from the fifth to the tenth spine]. Pectorals light, with darker shades. Anal fin with a dark colored margin. Caudal with small dusky spots," sometimes forming about four narrow concentric bars.

The fish reaches the length of about 6 inches.

This species is very rare in the North Atlantic, south to Cape Cod. Storer records the capture at Nahant Mass. in 1838. It has been taken by the U. S. Fish Commission at Grand Manan and Halifax, and by Prof. Verrill off Anticosti. De Kay had not met with the species in New York waters and his description is copied from that of Storer in his report upon *Fishes of Massachusetts*, page 63, 1839. De Kay called it the radiated shanny. Its occurrence in New York waters remains to be noted.

Genus STICHAEUS Reinhardt

Body moderately elongate, covered with small scales; teeth on jaws, vomer, and palatines. Lateral line present, single, running along side of back; pectorals and ventrals well developed. Dorsal moderately high, of spines only; gill openings continued forward below, the membranes scarcely united to the isthmus; pyloric caeca present. Arctic seas.

328 Stichaeus punctatus (Fabricius)

Spotted Blenny

Blennius punctatus FABRICIUS, Fauna Grönl. 153, 1780, Greenland.
Clinus punctatus RICHARDSON, Fauna Bor.-Amer. III, 88, 1836.
Gunnellus punctatus CUVIER & VALENCIENNES, Hist. Nat. Poiss. XI, 428 1836.
Stichaeus punctatus GÜNTHER, Cat. Fish. Brit. Mus. III, 283, 1861; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 775, 1883; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2439, 1898, pl. CCCXLV, fig. 841, 1900.

Body compressed, tapering at both ends, moderately elongate, its greatest depth one sixth to one seventh of total length without caudal. Head two ninths of total length without caudal;

mouth moderate, the maxillary extending to below front of pupil, one third as long as head, the lower jaw slightly shorter than upper; eye small, one fifth as long as head; snout slightly longer than eye. Dorsal origin over top of gill opening; dorsal fin subcontinuous with the caudal, its longest spine two sevenths as long as the head. Caudal fin rounded in adult (emarginate in young), the middle rays two thirds as long as the head. Anal origin under 17th spine of dorsal, the fin well separated from the caudal, its longest ray one third as long as the head. Pectoral extending to below the 14th spine of the dorsal, its length one sixth of the total without caudal. Ventral nearly under dorsal origin, one third as long as the head. Back little arched; ventral outline also arched. Lateral line single, in the upper fourth of the hight of body, and ending about the middle of the total length including caudal. Scales small, but larger than in Ulvaria subbifurcata. D. XLVIII to L; A. 32 to 36; V. I, 3; P. 15.

Color bright scarlet, the cheeks with five or six small dark blotches; smaller dark blotches on opercle and interopercle; a dark streak from snout through eye and extending behind the eye; five roundish dark spots, about as long as the eye, each with a white band near its upper margin, on the dorsal fin at almost regular distances apart; the anal fin with eight to ten narrow oblique crossbars; caudal with about six narrow, concentric, dark rings.

This blenny inhabits the Arctic seas from Greenland to North Siberia, south to Bristol Bay and Cape Cod. Young individuals were found in considerable numbers in Plover bay, Siberia, and at Cape Lisburne, Alaska. The species grows to the length of about 7 inches. The young are so different in appearance from the adult that they have been described as the type of a distinct genus. The occurrence of the species in New York waters is very doubtful.

Genus LUMPENUS Reinhardt

Body greatly elongate, moderately compressed, covered with small scales; lateral line indistinct or obsolete; head long; snout

short; no cirri; eyes large, placed high; mouth moderate, with a single row of rather small conic teeth on each jaw, palatine teeth present or absent; gill openings prolonged forward below, very narrowly united anteriorly to the isthmus, not forming a free fold across it; dorsal composed of numerous sharp, flexible, rather high spines; caudal fin long; anal many-rayed; pectorals large, more than one half length of head, the middle rays longest; ventrals well developed, jugular, I, 3 or I, 4; intestinal canal long; pyloric caeca present; no air bladder. Chiefly herbivorous. Northern seas.

Subgenus LEPTOBLENNIUS Gill

329 Lumpenus lampetraeformis (Walbaum)

Eel Blenny; Snakefish

Blennius lampetraeformis Walbaum, Artedi Gen. Pisc. III, 184, 1792; Iceland.

Blennius serpentinus Storer, Proc. Bost. Soc. Nat. Hist. III, 30, 1848; Massachusetts Bay; Hist. Fish. Mass. 91, pl. XVII, fig. 1, 1867.

Leptoblennius serpentinus Goode & Bean, Bull. Essex Inst. XI, 10, 1879; Massachusetts Bay; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 778, 1883.

Stichaeus islandicus Günther, Cat. Fish. Brit. Mus. III, 281, 1861.

Lumpenus lampetraeformis Collett, Norske Nord-Havs Exp. 71, 1880; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 778, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2438, pl. CCCXLIV, fig. 840, 1898.

The depth of the body is one fifteenth of the length, which is nine times the length of the head. Head not large, its sides sparsely covered with small scales; eye as long as snout; maxillary reaching front of pupil; gill openings extending forward below for a distance less than length of snout; pectorals long, seven eighths length of head; ventrals moderate, two and two thirds in head. D. LXXV; A. 50; V. I, 3.

Olive above with lighter cloudings; pale below; dorsal fin brownish, with broad, oblique, white bands; pectorals pale.

The snakefish inhabits the North Atlantic and Arctic on both shores, ranging south to Sweden and Norway, east to Spitzbergen; on our coast extending south to Cape Cod and perhaps Long Island. It is a common resident of the deep waters of Massachusetts bay, where it is a favorite food of the cod and

halibut. The species grows to the length of 12 to 15 inches. Other names for it are eel blenny and snake blenny. No record of its occurrence in New York waters has yet appeared, but it may be found in moderate depths off Long Island.

Family CRYPTACANTHODIDAE

Wrymouths

Genus CRYPTACANTHODES Storer

Body long and slender, compressed, naked, without lateral line; head cuboid, with vertical cheeks and conspicuous muciferous cavities; eyes small, placed high; mouth large, very oblique, the very heavy lower jaw prominent in front; jaws, vomer, and palatines with stoutish conic teeth, in few series; gill openings prolonged forward below, narrowly attached to the isthmus; dorsal fin of stoutish spines, hidden in the skin; dorsal and anal joined to caudal; pectorals short; ventrals wanting.

330 Cryptacanthodes maculatus Storer

Ghostfish; Wrymouth

Cryptacanthodes maculatus STORER, Rep. Fish. Mass. 28, 1839; Hist. Fish. Mass. 34, pl. VIII, fig. 6, 1867; DE KAY, N. Y. Fauna, Fishes, 63, pl. 18, fig. 50, 1842, from Massachusetts specimen; LINSLEY, Am. Jour. Sci. Arts, XLVII, 60, 1844, Long Island Sound; GÜNTHER, Cat. Fish. Brit. Mus. III, 291, 1861; GOODE & BEAN, Bull. Essex Inst. XI, 10, 1879; JORDAN & GILBERT, Bull. 16. U. S. Nat. Mus. 780, 1883; H. M. SMITH, Bull. U. S. F. C. 1897, 106, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2443, 1898, IV, pl. CCCXLV, fig. 843, 1900.

The depth of the body is one thirteenth of the length, which is six and one half times the length of the head. Eyes small, placed high, not so wide as interorbital space, which has two ridges and three pits; orbital rim raised; two deep pits behind eye at the temples, a deeper pit on top of head between them; a raised ridge continued backward on each side of head behind orbital rim; maxillary extending to beyond eye; pseudobranchiae small; pectorals short, three in head, their tips reaching beyond front of dorsal; vent a little in front of the middle of the body.

D. LXXIII; A. 50.

Light brownish, with several series of smallish dark spots, arranged in more or less regular rows, from the head to the

base of the caudal; vertical fin closely spotted with darker; head above thickly speckled; body sometimes ("*inornatus*") entirely immaculate. The wrymouth or ghostfish has been taken from Labrador to Long Island sound. It is recorded by Linsley in his catalogue of the *Fishes of Connecticut*. The species grows to a length of 24 inches or more. According to Dr Smith, it is very rare at Woods Hole Mass. A specimen from Woods Hole, now in the National Museum, was taken about 1875. Sep. 18, 1896, an individual 18 inches long was caught there in a fyke net set in Great harbor. In Massachusetts bay the fish is also rather rare. Storer, in his *History of the Fishes of Massachusetts*, 1867, mentioned seven specimens: one from Nahant, one from Dorchester, one from Provincetown, three from Massachusetts bay; the seventh was from a beach in Nova Scotia. The U. S. Fish Commission collected seven specimens on the coast of Massachusetts previous to 1879. There is an albino form of this fish, of which four individuals were known prior to 1879. One of these was obtained at Marblehead and another at Swampscott.

Family ANARHICHADIDAE

Wolf Fishes

Genus ANARHICHAS (Artedi) Linnaeus

Body moderately elongate, covered with rudimentary scales; head scaleless, without cirri, compressed, narrowed above, the profile strongly decurved; mouth wide, oblique; premaxillary not protractile; jaws with very strong conic canines anteriorly; lateral teeth of lower jaw either molars or with pointed tubercles; upper jaw without lateral teeth; vomer extremely thick and solid, with 2 series of coarse molar teeth; palatines with one or two similar series; gill membranes broadly joined to the isthmus; no lateral line; dorsal fin rather high, composed entirely of flexible spines which are enveloped in the skin; anal fin lower; caudal fin developed, free from dorsal and anal; no ventral fins; pectoral fins broad, placed low; air bladder present; no pyloric caeca. Northern seas.

331 Anarhichas lupus Linnaeus

Wolf Fish

Anarhichas lupus Linnaeus, Syst. Nat. ed. X, 247, 1758; H. M. Smith, Bull. U. S. F. C. 1897, 106, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2446, 1898; IV, pl. CCCXLVII, fig. 846, 1900.

Anarrhicas lupus Mitchill, Am. Month. Mag. II, 242, February, 1818; Storer, Rep. Fish. Mass. 69, 1839; De Kay, N. Y. Fauna, Fishes, 158, pl. 16, fig. 43, 1842.

Anarrhichas lupus Goode & Bean, Bull. Essex Inst. XI, 11, 1879.

Anarrhichas vomerinus Storer, Hist. Fish. Mass. 99, pl. XVIII, fig. 1, 1867.

The depth of the body is contained five and one half times in its length, which is six times the length of the head. Maxillary reaches beyond orbit; band of vomerine teeth extending much farther back than the short palatine band; pectorals large, rounded, two thirds length of head; dorsal high, beginning over the gill openings, its longest rays about half length of head.

D. LXII; A. 42.

Brownish; sides with numerous (9-12) very dark transverse bars, which are continued on the dorsal fin, besides numerous dark spots and reticulations; fins dark; caudal tipped with reddish.

This is the sea wolf of Mitchill, mentioned by him in the *American Monthly Magazine*, v. 2, p. 242. De Kay writes of the species as follows:

The voracious and savage character of this fish is manifest in the formidable array of teeth with which he is provided, and by his vicious and pugnacious propensities when first drawn from the water. . . He is known under the various popular names of cat, wolf fish, and sea cat. His ill-favored aspect causes him to be regarded with aversion by fishermen, but his flesh is by no means unsavory; when smoked it is said to have somewhat the flavor of salmon. He prefers rocky coasts and is said to spawn in May. Not unfrequently taken off Rockaway beach, as I am informed, in company with the common cod. This I suppose to be the most extreme southerly limit yet observed. In high northern latitudes it is said to attain to the length of 6 and 8 feet.

In the deep waters of Massachusetts bay it occurs frequently, approaching the shore, particularly in winter. In Vineyard sound it is quite rare and has been taken late in fall in traps

and also on lines fished for cod. The range of the species is, in the north Atlantic, south to Cape Cod and France. It is rather common both in America and Europe. In Norway the skin of the fish is tanned and makes a very good leather.

Group OPHIDIOIDEI

Eelpouts

Family ZOARCIDAE

Genus ZOARCES Gill

Body elongate, compressed, tapering posteriorly; head oblong, heavy, narrowed above, the profile decurved; mouth large; teeth strong, conic, bluntish, in two series in the front of each jaw and one series on the sides; teeth in outer series larger; no teeth on vomer or palatines; dorsal fin very long, low, some of its posterior rays much lower than the others, developed as sharp spines; pectoral fins broad; ventrals jugular, of three or four soft rays; scales small, not imbricated, embedded in the skin; lateral line slender, lateral in position; size large; species viviparous. The American and Asiatic species (subgenus Macrozoarces) differ from the European type of Zoarces (Cuvier) in the increased number of fin rays and vertebrae. In Zoarces viviparus (Linnaeus), the European eelpout, the dorsal rays are about 100, the anal about 85, and the number of vertebrae is proportionally diminished.

332 Zoarces anguillaris (Peck)

Muttonfish; Ling; Eelpout

Blennius anguillaris PECK, Mem. Am. Ac. Sci. II, 46, figure, 1804. New Hampshire.

Blennius ciliatus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 374, pl. I, fig. 6, 1815.

Blennius labrosus MITCHILL, op. cit. 375, pl. I, fig. 7, 1815.

Zoarces anguillaris STORER, Rep. Fish. Mass. 66, 1839; DE KAY, N. Y. Fauna, Fishes, 155, pl. 16, fig. 45, 1842; GUNTHER, Cat. Fish. Brit. Mus. III, 296, 1861; STORER, Hist. Fish. Mass. 97, pl. XVII, fig. 4, 1867; GOODE & BEAN, Bull. Essex Inst. XI, 9, 1879; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 784, 1883; H. M. SMITH, Bull. U. S. F. C. 1897, 106, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2457, 1898; IV, pl. CCCXLVIII, fig. 850, 1900.

The depth of the body is one seventh of the length, which is six times the length of the head. Maxillary reaching beyond

orbit; pectoral long, about two thirds length of head; ventrals one fifth head; highest ray of dorsal about equal to snout; the posterior spines about one third length of eye; first ray of dorsal above preopercle. D. 95, XVIII, 17; A. 105.

Reddish brown, mottled with olive, the scales paler than the skin about them; dorsal fin marked with darker; a dark streak from eye across cheek and opercles; lower jaw included.

This fish grows to the length of about 3 feet. De Kay noticed it most abundantly in the New York market in February and March. He states that it is caught on the coast in company with the common cod. It feeds on various marine shells and affords a very savory food. At the time of his writing it was called by the fishermen ling and conger eel. De Kay employed for it the English name eelpout. Fishermen who go out for cod off Sandy Hook at the present time catch this fish in large numbers and know it under the name of muttonfish. The range of the fish is from Labrador to Delaware. It is rather common north of Cape Cod. Dr Smith says it is abundant in the fall off Gayhead and Cuttyhunk; it is caught while line fishing for cod on rock bottom and occasionally late in fall in Vineyard sound, off Great harbor, on lines baited for tautog. In Massachusetts bay it is a common resident of deep water, frequently approaching the shore.

Family OPHIDIIDAE

Genus RISSOLA Jordan & Evermann

This genus contains species agreeing with Ophidion in general characters, but with the air bladder short, broad, spherical or kidney-shaped, with a posterior foramen. Species chiefly of the Mediterranean.

333 **Rissola marginata** (De Kay)

Slippery Dick

Ophidium marginatum DE KAY, N. Y. Fauna, Fishes, 315, pl. 52, fig. 169, 1842, New York Harbor; BAIRD, Ninth Ann. Rep. Smith. Inst. 351, 1855; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 792, 1883; BEAN, Bull. U. S. F. C. VII, 135, 1888.

Rissola marginata JORDAN & EVERMANN, Check-List Fish. N. & M. A. 483, 1896; Bull. 47, U. S. Nat. Mus. III, 2489, 1898; IV, pl. CCCLIII, fig. 868, 1900; BEAN, Bull. Am. Mus. Nat. Hist. IX, 370, 1897.

Ophidium barbatum MITCHILL. Trans. Lit. & Phil. Soc. N. Y. I, 362, pl. I, fig. 2, 1815.

De Kay writes of the species as follows:

This very rare and curious species was taken in a seine in the harbor of New York in company with a school of the striped bass. It is doubtless the O. barbatum of my venerable friend, Dr Mitchill, which is too succinctly noted in the work cited above. . . It has so much the habit of some of the Gadidae, and more especially of the genus Brotula, that our fishermen call it the *little cusk*.

The fish inhabits the coast of the United States from New York south to Pensacola and Texas. It is not very common. It grows to the length of about 10 inches. A specimen was taken in Great Egg Harbor bay during the winter of 1853–54, but collectors who have visited the region since have not found it again. In Gravesend bay, where the species is rare, an example was obtained Oct. 24, 1894. The fish is known there as Slippery Dick.

Suborder CRANIOMI

Family TRIGLIDAE

Gurnards

Genus PRIONOTUS Lacépède

Body subfusiform; profile of head descending to the broad, depressed snout, which is much longer than the small eye; eyes close together, high up; surface of head entirely bony, the bones rough with ridges and granulations; scales on head few or none; preopercle with one or two sharp spines at its angle; opercle with a sharp spine; nape with two strong spines, a spine on shoulder girdle; mouth rather broad; bands of small, almost granular, teeth on jaws, vomer, and palatines; gill membranes nearly separate, free from isthmus; gill rakers rather long; body covered with small, rough scales, which are not keeled; lateral line continuous; scales on breast very small; dorsal fins distinct, the first of 8 to 10 rather stout spines, the third usually highest, but mostly shorter than head; anal fin similar to soft dorsal; pectoral fin with the three lower anterior rays thickened, entirely free from each other and from the fin; ventrals I, 5,

wide apart, with a flat space between them, the inner rays longest; pyloric caeca in moderate number; air bladder generally with lateral muscles and divided into two lateral parts; vertebrae 10 or 11 + 15. Species numerous, all but one being American. Representing in America the old world genus Trigla. Some of them in deep water. They are well defined and easily recognized, but vary considerably with age, and are not easily thrown into subordinate groups. . . Young examples in most cases differ from the adults in the following respects, in addition to those characters which usually distinguish young fishes. The spines on the head are sharper, more conspicuous, and more compressed in the young, and some spines, specially those on the side of the head, disappear entirely with age. The interorbital space is more concave in the young. The pectoral fins are also much shorter. The gill rakers are longer in the young, and proportionately more slender, and some of the color markings—specially the darker cross shades—are more conspicuous, while the spots on body and fins are less so.

334 Prionotus carolinus (Linnaeus)

Sea Robin; Gurnard

Trigla carolina Linnaeus, Mantissa, 528.

Trigla palmipes Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 431, pl. IV, fig. 5, 1815, New York Harbor.

Prionotus palmipes Storer, Hist. Fish. Mass. 18, pl. V, fig. 1, 1867; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 734, 1883; Goode, Fish & Fish. Ind. U. S. I, 255, pl. 71, 1884.

Prionotus carolinus Cuvier & Valenciennes, Hist. Nat. Poiss. VI, 90, 1829; De Kay, N. Y. Fauna, Fishes, 46, pl. 5, fig. 15, 1842; Günther, Cat. Fish. Brit. Mus. II, 192, 1860; Bean, Bull. Am. Mus. Nat. Hist. IX, 371, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 106, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. II, 2156, 1898; IV, pl. CCCXVIII, fig. 768, 1900.

The depth of the body is one fifth of the length, which is three times the length of the head. Head comparatively smooth; preopercular spine strong; band of palatine teeth short and broad, shorter than eye; pectorals short, not reaching middle of second dorsal, two and one third in length; pectoral appendages strong, more or less dilated at their tips; ventrals long, reaching anal;

gill rakers rather short, about 10 below angle; maxillary three and one third in head. D. X–13; A. 12; Lat. l. .58.

Brownish above, clouded with darker; throat and branchiostegals dark; a distinct dark blotch above on membrane between fourth and fifth dorsal spines, this ocellated below; two longitudinal light streaks below dorsal blotch; second dorsal with oblique whitish streaks.

The sea robin, known also as the red-winged sea robin, common gurnard, flying fish, butterfly fish, wingfish, grunter, and cuckoo fish, is very common on our east coast, its range extending from the coast of Maine to South Carolina, chiefly northward. The name flying fish is applied to the species in Great Egg bay, N. J. This sea robin appears in Gravesend bay in May, and is caught in the shad fyke nets. It is the earliest of the sea robins to arrive. At Woods Hole Mass., according to Dr Smith, it appears in May or June and remains till October or later, and it is more abundant than the striped sea robin.

This fish grows to the length of about 1 foot. It is not a marketable fish, and causes fishermen a great deal of annoyance by its wonderful voracity, and yet its flesh is firm and white, and the species deserves a place among the food fishes. It feeds on crabs, shrimp and similar crustaceans, and occurs on clean bottoms. This sea robin begins to spawn at Woods Hole early in June. Its eggs are bright orange. The young are very common in Waquoit bay in summer, but are rather rare elsewhere. The young were found in Great South bay, at Point of Woods, and both sides of Fire Island inlet in August and September. Adults are also found in large numbers at Fire Island and at other parts of Great South bay. This fish is taken in enormous numbers in pound nets in spring and summer. Curiously enough, De Kay refers to this as a very rare species. He says that in the course of eight years he has not met with more than six or eight individuals. One specimen which he examined, had its stomach filled with the remains of crabs.

335 Prionotus strigatus Cuv. & Val.

Red-winged Sea Robin

Trigla lineata Mitchill, Trans. Lit. & Phil. Soc N. Y. I, 430, pl. IV, fig. 4, 1815; not *Trigla lineata* Bloch.

Trigla strigata Cuvier, Règne Anim. ed. II, 2, 161, 1829, New York.

Prionotus lineatus De Kay, N. Y. Fauna, Fishes, 45, pl. 4, fig. 12, 1842; Günther, Cat. Fish. Brit. Mus. II, 192, 1860.

Prionotus evolans var. *lineatus*, Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 736, 1883.

Prionotus evolans Goode, Fish & Fish. Ind. U. S. I, 255, pl. 71, 1884; not *Trigla evolans* Linnaeus.

Prionotus strigatus Cuvier & Valenciennes, Hist. Nat. Poiss. IV, 86, 1829; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 974, 1883; Bean, 19th Rep. Comm. Fish. N. Y. 250, 1890; Bull. Am. Mus. Nat. Hist. IX, 371, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 106, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. II, 2167, 1898.

The length of the head is contained two and two thirds times in the length of the body, which is four and one half times the depth of the body. The length of the eye is contained two and one half times in the length of the snout. Gill rakers rather long and slender, 15 below angle; band of palatine teeth wide, shorter than eye; spines on head moderate in size, compressed, the one at upper posterior angle of orbit little developed; membranous edge of opercle scaly; ventral reaching to front of anal; pectoral reaching past middle of soft dorsal and anal, from one and seven eighths to two and one fourth in length. D. X–12; A. 11; Lat. l. about 60.

Olive brown above, mottled and spotted with blackish; whitish below; a narrow streak along the lateral line, with a broader one below it, which terminates behind in a series of spots and blotches; lower jaw and branchiostegal membranes sometimes bright orange yellow; pectorals blackish edged with olivaceous and orange, with numerous transverse dark lines; membrane of spinous dorsal with a black blotch between third and sixth spines; soft dorsal plain or with two black blotches at base; ventrals and anal orange; pectoral appendages slender, dusky. Cape Cod to Cape Hatteras; common northward. Perhaps a distinct species but seeming to vary into P. evolans.

The red-winged sea robin is distinguished from the striped sea robin by the following characters: pectoral with its rays each crossed by fine black bars, these specially distinct toward the base of the fin; free rays spotted; scales comparatively small, 10+1+23 in a vertical line from last dorsal spine to vent; interorbital area broad and almost flat, its width a little more than length of eye; first dorsal spine granulated; second spine four elevenths length of head; pectorals about one half as long as body.

In the striped sea robin the pectoral rays are all plain blackish; free rays plain dusky; scales 8+1+21 in a vertical line from last dorsal spine to vent; interorbital space more deeply concave, its width in adult not quite length of eye; first dorsal spine nearly smooth; second spine one third length of head; pectorals a little more than one half as long as body.

This fish is found on our Atlantic coast from Cape Cod to Virginia. It is very common in shallow water and is extremely close to Prionotus evolans, of which it may be a geographic variety. Drs Jordan and Evermann have not however seen examples intermediate between the striped sea robin and the red-winged species. This fish is the Prionotus lineatus of De Kay.[1] De Kay distinguishes this fish, which he calls the banded gurnard, by the broad, reddish brown line along the sides below the lateral line, as well as by other characters. He says it is not uncommon and is known under the various popular names, grunter, gurnard, sea robin and flying fish. He states that the banded gurnard is seldom eaten as food. This is also the gurnard or sea robin, Trigla lineata, of Mitchill in the Trans. Lit. & Phil. Soc. N. Y. I. 430, pl. 4, fig. 4. 1815.

The red-winged sea robin comes into Gravesend bay in May, but later than the common species. It was found more abundantly in Great South bay than the unstriped species. Individuals were taken in Blue Point cove, and at Fire Island, late in September. This fish grows larger than the other species

[1] New York Fauna, Fishes. 1842. p. 45, pl. 4, fig. 12.

and is much handsomer; the young are specially interesting on account of the great development of their pectoral fins.

336 **Prionotus tribulus** (Cuvier)

Big-headed Sea Robin

Trigla tribulus Cuvier, Règne Anim. ed. 2, II, 161, 1829, America.
Prionotus tribulus Cuvier & Valenciennes, Hist. Nat. Poiss. IV, 98, pl. 74, 1829, New York; De Kay, N. Y. Fauna, Fishes 48, pl. 70, fig. 226, 1842; Günther, Cat. Fish. Brit. Mus. II, 195, 1860; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 735, 1883; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. II, 2171, 1898.

Pectorals rather short, not reaching end of dorsal, twice in length to base of caudal; pectoral appendages thick, tapering. Body robust. The depth is one fourth of the length of the body, which is two and one half times the length of the head. Head shorter and broader, snout shorter, and bones more strongly striate than in P. evolans; interorbital space deeply concave; occipital and superorbital spines very strong and much compressed; band of palatine teeth as long as eye; gill rakers shortish, nine below angle; membranous edge of opercle scaly. D. X–12; A. 11; Lat. l. about 50.

Dark brown above, with darker blotches and numerous small, pale spots; belly pale; a black blotch at base of mandible; membrane of spinous dorsal, between the third and sixth spines, with a black blotch above; second dorsal with brownish spots, forming oblique bars, and with two dark blotches at base, the posterior blotch continued obliquely downward and forward to below the lateral line; pectoral olive brown, with dark crossbars, which are more distinct toward the tip of the fin, its upper edge white, pectoral appendages with dark spots; basal half of caudal paler.

This gurnard is very common on the south Atlantic coast and occasionally ranges northward to Long Island. It is well separated from the other sea robins of the Atlantic by the greater development of the spines of the head. "The young have these spines much larger and more compressed than the adult, and in the very young three or four strong knifelike

spines are developed on each side of the snout. In very young individuals the spine at the base of the preopercular spine is much larger than the latter." De Kay obtains his description of this fish from Cuvier and Valenciennes, but he saw very small individuals which he at first confounded with the young of the red-winged sea robin. Cuvier states that he received numerous specimens of the species from New York. De Kay mentions among the characteristics of the fish the long pectoral which reaches the end of the anal fin and acute spines of the head which are flattened like sword blades. As for colors he gives the following: "The first dorsal fin has a black spot between the fourth and sixth ray. The second with two black spots along its base; one from the fifth to the seventh, the other between the fourth and sixth rays; pectorals blackish, more specially on the interior where the upper border is whitish. Body brownish above, lightish beneath." Specimens 8 inches long are recorded.

Genus TRIGLA (Artedi) Linnaeus

This genus differs from Chelidonichthys, with which it agrees in the absence of palatine teeth, in having the sides of the body armed with transverse bony plates, crossing the lateral line. Species numerous; very abundant in the Mediterranean.

Genus CHELIDONICHTHYS Kaup

This genus differs from Prionotus chiefly in the absence of palatine teeth. The scales are much smaller, and the pectoral fins less developed; a series of bony, spinous plates extends along the base of the dorsal fin, a pair of them to each ray, the fin thus running in a shallow groove; there are no plates along the lateral line; caudal fin usually emarginate; lateral line usually forked at base of caudal, the branches running to tip of fin. The numerous species abound on the coasts of Europe, Africa and India, ranging north to Japan.

337 Trigla cuculus Linnaeus

Red Gurnard

Trigla cuculus LINNAEUS, Syst. Nat. ed. X, I, 301, 1758; CUVIER & VALENCIENNES, Hist. Nat. Poiss. IV, 26, 1829; DE KAY, N. Y. Fauna, Fishes, 43, pl. 70, fig. 225, 1842; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. II, 2177, 1898.

The depth of the body is one fifth of the length, which is three and one half times the length of the head. Rose-red; profile of snout rather steep, slightly concave; preorbital with short denticulations; maxillary nearly reaching front of orbit; lateral line with a series of unarmed plates, which are deeper than long; first dorsal spine tuberculated; second longest, two thirds length of head; pectoral reaching past front of anal. D. IX–18; A. 17; Lat. l. 75.

The red gurnard is a native of southern Europe. It is said by Cuvier to have been once brought from New York by Milbert, but this is a very doubtful record, as no collector has recently found any species of Trigla in American waters. De Kay did not see this fish on the coast of New York, and he copied his description from Cuvier and Valenciennes. De Kay states that Cuvier and Valenciennes mention having received "a specimen from New York, which so much resembles the T. cuculus, not only in all its generalities but even in its most minute details, that it is very difficult for us not to consider it the same species; but, as our specimen was not recent, it may possibly present some distinct characters."

Family CEPHALACANTHIDAE

Flying Gurnards

Genus CEPHALACANTHUS Lacépède

Body elongate, subquadrangular, tapering behind; head very blunt, quadrangular, its surface almost entirely bony; nasals, preorbitals, suborbitals, and bones of top of head united into a shield; nuchal part of shield on each side produced backward in a bony ridge, ending in a strong spine, which reaches past front of dorsal; interocular space deeply concave; preorbitals forming a projecting roof above the jaws; preopercle produced in a very long rough spine; cheeks and opercles with small scales; opercle smaller than eye; gill openings narrow, vertical, separated by a very broad, scaly isthmus; pseudobranchiae large; gill rakers minute; mouth small, lower jaw included; jaws with granular teeth; no teeth on vomer or palatines; scales

bony, strongly keeled; two serrated, knifelike appendages at base of tail; first dorsal of four or five rather high flexible spines, the first one or two spines nearly free from the others; an immovable spine between the dorsals; anal and second dorsal short, of slender rays; caudal small, lunate; pectoral fins divided to the base into two parts, the anterior portion about as long as the head, of about six rays, closely connected; the posterior and larger portion more than twice length of head, reaching nearly to caudal in the adult, much shorter in the young; these rays very slender, simple, wide apart at tip; ventral rays I, 4, the long fins pointed, their bases close together, the inner rays shortest; air bladder with two lateral parts, each with a large muscle; pyloric caeca numerous; vertebrae 9+13=22. Warm seas; the adult able to move in the air like the true flying fish, but for shorter distances. Two species known, one of them (*C. spinarella*) East Indian.

338 Cephalacanthus volitans (Linnaeus)

Flying Gurnard; Flying Robin

Trigla volitans Linnaeus, Syst. Nat. ed. X, I, 302, 1758.

Polynemus serradiatus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, pl. IV, fig. 10, 1815; Am. Month. Mag. II, 323, March, 1818.

Dactylopterus volitans Cuvier & Valenciennes, Hist. Nat. Poiss. IV, 117, 1829; De Kay, N. Y. Fauna, Fishes, 49, pl. 17, fig. 46; Günther, Cat. Fish. Brit. Mus. II, 221, 1860.

Cephalacanthus volitans Bean, Bull. U. S. F. C. VII, 136, 1888; Bull. Am. Mus. Nat. Hist. IX, 371, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 106, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. II, 2183, 1898; IV, pl. CCCXXIII, fig. 778, 1900.

Body elongate, subquadrangular, tapering to caudal, its depth about one sixth of total length; profile blunt, the head being quadrangular in shape; mouth rather small, the lower jaw included; granular teeth in jaws; no teeth on vomer and palatines; eye large, its diameter being contained about three and one half times in length of head; bones of top of head, preorbitals, and suborbitals, forming a shield, the nuchal part on each side being produced backward in a bony ridge and ending in a strong spine which reaches to the fourth or fifth dorsal spine; another spine extends backward from the preopercle past ventrals; pectorals in adults reaching almost to caudal,

shorter in the young; the first dorsal originates over the ventrals, its longest spine is equal in length to the distance from tip of snout to posterior margin of orbit; the second dorsal rays are slightly longer; anal base shorter than either dorsal base, equal to base of first six rays of second dorsal; caudal emarginate; ventrals as long as head. D. II–V, 8; A. 6.

Color of varying shades of greenish, olive, and reddish brown on upper parts of body, paler underneath; irregular markings of dusky and vermilion, varying to salmon yellow; pectorals with bright blue streaks near base, and blue spots and bars toward the tip, their under sides glaucous blue edged with darker; three brownish red bars on caudal fin.

The flying gurnard is found in the Atlantic ocean on both coasts. It is very abundant on our south Atlantic coast and in the Gulf of Mexico. It ranges as far north as Cape Cod. Several specimens were obtained in Great Egg Harbor bay in August and September 1887. Their lengths were respectively $2\frac{1}{2}$, $6\frac{1}{2}$ and $7\frac{7}{10}$ inches. In Gravesend bay, L. I., this is an uncommon species. An individual was taken there Oct. 30, 1897. Dr Smith says that a few are taken every year late in the fall in the vicinity of Woods Hole Mass. They sometimes come ashore in Buzzards bay and Vineyard sound, benumbed by cold. They are not so abundant now as they were prior to 1887. Mitchill described and figured the fish in 1815 under the name Polynemus sexradiatus.

De Kay calls it the sea swallow and has the following notes on it:

Dr Mitchill, in his memoir on the *Fishes of New York* in 1814 (1815), gave a good figure of this species; and in his supplement to this memoir in the *American Monthly Magazine* in 1818 furnished a detailed description which sufficiently establishes its identity with D. volitans. . . The subject of our examination was caught in a net in the harbor in the month of August. If our species be identical with that of Europe, it has a wide geographical distribution. On the American coast it ranges from Brazil to Newfoundland. By means of its immense pectorals, it is enabled to spring from the ocean and support itself for some time in the air. This is often done to protect itself from its enemies. It feeds on various small crustacea.

Suborder DISCOCEPHALI

Family ECHENEIDIDAE

Remoras

Genus ECHENEIS (Artedi) Linnaeus

Body comparatively elongate, the vertebrae 14-16+30; disk long, of 20 to 28 laminae; pectoral pointed, its rays soft and flexible; soft dorsal and anal long, of 30 to 41 rays each; caudal lunate in the adult, convex in the young. Species of wide distribution, attaching themselves mainly to sea turtles and large fishes.

339 Echeneis naucrates Linnaeus

Sharksucker; Sucking Fish

Echeneis neucrates (misprint for *naucrates*) LINNAEUS, Syst. Nat. ed. X, I, 261, 1758.

Echeneis naucrates MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 377, 1815; DE KAY, N. Y. Fauna, Fish. 308, 1842; GUNTHER, Cat. Fish. Brit. Mus. II, 384, 1860; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 416, 1883; BEAN, Bull. Am. Mus. Nat. Hist. IX, 371, 1897; H. M. SMITH, Bull. U. S. F. C. 1897, 106, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2269, 1898; IV, pl. CCCXXIX, fig. 796, 1900.

Echeneis albacauda MITCHILL, Am. Month. Mag. II, 244, February, 1818.

Echeneis albicauda DE KAY, N. Y. Fauna, Fish. 307, pl. 54, fig. 177, 1842; Long Island; Hudson River.

Body elongate, subterete, slender. The length of the body is five and one half times the length of the head. The disk is contained three and two thirds times in the length of the body, which is about seven and one half times the width between the pectorals; disk long. Dorsal and anal fins longer than the disk; inner rays of ventral fin narrowly adnate to the abdomen; caudal becoming emarginate with age. Vertebrae 14+16. Vertical fins low; pectorals three fourths length of head, rather long and acute; lower jaw projecting, with the tip flexible; maxillary barely reaching vertical from nostril. D. XXI to XXV–32 to 41; A. 34 (32–38).

Brownish; the belly dark like the back, as usual in this family; sides with a broad stripe of darker edged with whitish, extending through eye to snout; caudal black, its outer angle whitish; pectorals and ventrals black, sometimes bordered with pale; dorsal and anal broadly edged with white anteriorly.

The sharksucker or sucking fish is also known as the remora. It inhabits all warm seas, ranging north to Cape Cod and San Francisco. De Kay describes this species under the name of the white-tailed remora, and the Indian remora. He figures the species on pl. 54, fig. 177, of his *New York Fauna*. He says it is not uncommon on the coast of Long Island, and has been several times brought to him by those who took it in ordinary seines. He states that it is called sharksucker. He saw a specimen which had ascended a considerable distance up the Hudson river. He states further that it appears most commonly in July and August. In Mitchill's account of the fishes of New York, an individual measuring 31 inches in length, and weighing 4 pounds 10 ounces is mentioned. In Gravesend bay the species is found in summer only attached to sharks, usually the sand shark, Carcharias littoralis. An individual obtained there July 28, 1897, lived and fed till November 13, when it ceased feeding, and Nov. 23 it died because of the low temperature of the water. In captivity the fish usually remains stationary on the bottom, with the head and anterior part of the body slightly raised, but will often rise to the surface to take pieces of clam or fish from the hand.

At Woods Hole Mass., according to Dr Smith, the fish is not uncommon. An example 21 inches long was caught at West Falmouth July 16, 1897, on a hook baited with fresh clam. In August 1901 an individual of medium size was caught with a hook on the Cinders, Fire Island, by an angler. This was the only specimen seen during the summer.

340 Echeneis naucrateoides Zuiew.

Pilot Sucker

Echeneis naucrateoides Zuiew, Nova Acta Ac. Sci. Imp. Petropol. IV, 279, 1789; Goode & Bean, Bull. Essex Inst. XI, 20, 1879; H. M. Smith, Bull. U. S. F. C. 1897, 106, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2270, 1898.

Echeneis holbrooki Günther, Cat. Fish. Brit. Mus. II, 382, 1860.

The form of the body is similar to that of the sharksucker; its depth forms $\frac{1}{11}$ of the total length. The length of the head is one fifth of the total. The cephalic disk is very long, nearly

one fourth of the total, and equal to twice the width of the body between the pectorals. The number of laminae is 20 or 21, and they are far apart. The radial formula, D. XX or XXI–32 to 35; A. 33 to 35.

The color is the same as in the sharksucker. This species ranges from Cape Cod to the West Indies. It is common on our south Atlantic coast. An individual was recorded by Prof. Baird at Woods Hole Mass. in 1871, and a number of specimens were taken during the next 10 years. According to Dr Smith, however, it has not recently been collected there.

Genus REMORA Gill

Body rather robust, the vertebrae 12+15=27; disk shortish, of 13 to 18 laminae; pectoral rounded, its rays soft and flexible; soft dorsal and anal moderate, of 20 to 30 rays; caudal subtruncate. Species attaching themselves to large fishes, specially to sharks.

341 Remora remora (Linnaeus)

Remora

Echeneis remora Linnaeus, Syst. Nat. ed. X, I, 260, 1758; Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 378, 1815; De Kay, N. Y. Fauna, Fishes, 309, 1842; Günther, Cat. Fish. Brit. Mus. II, 378, 1860; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 417, 1883.

Remora jacobaea Goode & Bean, Bull. Essex Inst. XI, 21, 1879.

Remora remora Jordan & Evermann, Check-List Fish. N. A. 490, 1896; H. M. Smith, Bull. U. S. F. C. 1897, 106, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2271, 1898.

Body and tail comparatively robust, the latter compressed. The length of the body is four times the length of the head, two and three fourths times the length of the disk and five and one fourth times the width between pectorals. Pectoral fin rounded, short, and broad, the rays soft and flexible; ventral fins adnate to the abdomen for more than half the length of their inner edge. Tip of lower jaw not produced into a flap. Vertebrae 12+15. Head broad and depressed; disk longer than the dorsal or anal fin; maxillary scarcely reaching front of orbit; caudal lunate; vertical fins rather high; pectoral three fifths length of head. D. XVIII–23; A. 25.

Uniform dark brown. Warm seas, north to New York and San Francisco; usually found attached to large sharks.

In 1815, Mitchill described this species under the name of small oceanic sucker. De Kay did not see the fish but obtained his information from the writings of Mitchill and Schoeff. He states that Schoeff saw this remora taken from the bottoms of vessels in the harbor of New York. At Woods Hole Mass., according to Dr Smith, the remora is rare. It was reported by Prof. Baird in 1871, and the specimen in the collection at that place was taken in July. It is usually found attached to large sharks. In 1879 Messrs Goode and Bean found in the museum of the Essex Institute, at Salem Mass. a specimen which was reported to have come from Salem harbor. If it really was obtained in that locality, it must have been attached to the bottom of some vessel from a southern port.

342 Remora brachyptera (Lowe)

Swordfish Sucker

Echeneis brachyptera Lowe, Proc. Zool. Soc. Lond. 89, 1839, Madeira, Günther, Cat. Fish. Brit. Mus. II, 378, 1860; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 417, 1883.

Echeneis quatuordecimlaminatus Storer, Rep. Fish. Mass. 155, 1839; De Kay, N. Y. Fauna, Fish. 309, 1842 (extralimital); Storer, Hist. Fish. Mass. 212, pl. XXXII, fig. 4, 1867.

Remoropsis brachypterus Gill, Proc. Ac. Nat. Sci. Phila. 60, 1864.

Remoropsis brachyptera Goode & Bean, Bull. Essex Inst. XI, 21, 1879.

Remora brachyptera Jordan & Evermann, Check-List Fish. N. A. 490, 1896. H. M. Smith, Bull. U. S. F. C. 1897, 106, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2272, 1898; IV, pl. CCCXXX, fig. 797 797a, 1900.

The length of the head is contained nearly four times in the length of the body, which is six and one half times the width between the pectorals. Body robust, the greatest depth nearly twice the length of the short pectoral fins; disk shorter than base of dorsal, rather broad; upper jaw angular; caudal nearly truncate. D. XVI–30; A. 26.

Light brown, darker below; fins paler.

The swordfish sucker is an inhabitant of warm seas, ranging northward to Cape Cod, and to Japan. It is a small species and has usually been found attached to the swordfish. Dr Storer, in his *Report on the Fishes of Massachusetts*, 1839, recorded a specimen from Holmes Hole, Marthas Vineyard. At Woods Hole

Mass. this sucker is rare. There is in the U. S. National Museum an individual from that locality. Storer again describes the species in his *History of the Fishes of Massachusetts*, 1867, and gives a figure of it. De Kay refers to this description on page 309 of his *New York Fauna*. He regards this fish as one of the extralimital species. Goode and Bean in 1879 recorded it as a parasite of the swordfish, which not infrequently accompanies that species into Massachusetts bay. They had also seen specimens from Newfoundland.

Genus RHOMBOCHIRUS Gill

This genus agrees with Remora in every respect excepting the structure of the pectoral fins. These are short and broad, rhombic in outline, the rays all flat, broad and stiff, being partially ossified, though showing the usual articulations; upper rays of pectoral broader than the others. One species known.

343 Rhombochirus osteochir (Cuvier)

Spearfish Sucker

Echeneis osteochir CUVIER, Règne Anim. ed. 2, II, 348, 1829; GÜNTHER, Cat. Fish. Brit. Mus. II, 381, 1860; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 418, 1883.

Rhombochirus osteochir JORDAN & EVERMANN, Check-List Fish. N. A. 490, 1896; H. M. SMITH, Bull. U. S. F. C. 1897, 106, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2273, 1898; IV, pl. CCCXXX, fig. 798, 1900.

The length of the body is four and two thirds times the length of the head, two and one fourth times the length of the disk and five times the width between the pectorals; mouth very small, maxillary not reaching to the line of orbit; disk very large, broader and rougher than in Echeneis remora, extending forward beyond tip of snout; caudal fin emarginate, with rounded angles. D. XVIII–21 to 23; A. 20; P. 20.

Light brown; under side of head, ventral line, part of ventrals and a spot on pectorals pale.

This small species inhabits the West Indies and ranges northward occasionally to Cape Cod. It is parasitic on the species of spearfish, and is rather rare. It was recorded at Woods Hole Mass. by Prof. Baird in 1871. According to Dr Smith, a specimen was taken Aug. 6, 1886, in a fish trap at Quissett harbor, near Woods Hole.

Suborder ANACANTHINI

Jugular Fishes

Family MERLUCCIIDAE

Whitings

Genus MERLUCIUS Rafinesque

Body elongate, covered with small, deciduous scales; head slender, conic, the snout long, depressed; a well-defined, oblong, triangular excavation at the forehead, bounded by the ridges on the separated frontal bones, these ridges converging backward into the low occipital crest; eye rather large; edge of preopercle free; preopercle with a channel behind its crest, crossed by short radiating ridges; mouth large, oblique; maxillary extending to opposite the eye; lower jaw longer; no barbels; jaws with slender teeth, of various sizes, in about two series, those of the inner row longer and movable; vomer with similar teeth; palatines toothless; branchiostegals seven; gill rakers long; gill membranes not united; dorsal fins two, well separated, the first short, the second long, with a deep emargination; anal emarginate, similar to second dorsal; ventral fins well developed, with about seven rays; vertebrae peculiarly modified, the neural spines well developed and wedged into one another; frontal bone double and the skull otherwise peculiar in several respects. Species several, very similar in appearance, ill-favored fishes of soft flesh and fragile fins, inhabiting water of some depth. Large, voracious, little valued as food.

344 **Merlucius bilinearis** (Mitchill)

Whiting; Silver Hake

Stomodon Bilinearis MITCHILL, Rep. Fish. N. Y. 7, 1814.
Gadus merlucius MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I. 371, 1815.
Gadus albidus MITCHILL, Jour. Ac. Nat. Sci. Phila. I, 409, 1817.
Merlucius albidus DE KAY, N. Y. Fauna, Fishes 280, pl. 46, fig. 148, 1842; STORER, Hist. Fish. Mass. 185, pl. XXVIII, fig. 2, 1867.
Merlucius bilinearis GOODE & BEAN, Bull. Essex Inst. XI, 9, 1879; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 809, 1883; BEAN, 19th Rep. Comm. Fish. N. Y. 249, pl. IV, fig. 5, 1890; GOODE & BEAN, Oceanic Ichth. 386, fig. 330, 1896; H. M. SMITH, Bull. U. S. F. C. 1897, 107, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2530, 1898; BEAN, 52d Ann. Rep. N. Y. State Mus. 109, 1900.

The length of the body is six and one half times the depth of the body and three and three fourths times the length of the head. Top of head with W-shaped ridges very conspicuous; eye shorter than snout and less than interorbital in width; maxillary reaching posterior border of pupil; teeth not very large, smaller than in M. s m i r i d u s; scales larger than in other species; pectorals and ventrals long, the latter reaching three fourths distance to vent, their length being three fifths that of the head. D. 13–41; A. 40; Lat. l. 100–110.

Grayish, darker above, dull silvery below; axil and edge of pectoral somewhat blackish; inside of opercle dusky silvery; inside of mouth dusky bluish; peritoneum nearly black.

The whiting is known by the additional names of hake and silver hake. Mitchill describes it as the hake, G a d u s m e r l u c i u s. He states that it is caught with the other cod. De Kay called it the American hake. He styles it a rare fish in the waters of New York, and, when caught, always associated with the common cod. The specimen described by De Kay was taken in November off Sandy Hook. In his *New York Fauna*, he mentions Mitchill's description of a specimen which measured 21 inches in length.

The whiting ranges from Labrador to Virginia. Young examples have been found even farther south in very deep water. This fish occurs in Gravesend bay in spring and fall. In Great South bay no individuals were seen by the writer during the summer, but an individual was obtained late in the fall by Capt. Thurber. Oct. 28, 1898, several examples were received from the Atlantic, off Southampton.

According to Dr Smith, the species is abundant every fall at Woods Hole Mass. and some years it is common in summer. The fish swims close to the shore, and is caught in considerable numbers at Buzzard's bay at night with spears. Large individuals weighing 5 or 6 pounds are caught in traps. The young measuring $2\frac{1}{2}$ to 3 inches long, are seined in the fall about Woods Hole. The names in use for the fish in that locality are silver hake, whiting, and frostfish. In Massachusetts bay the whiting is a

frequent visitor to the shores and is probably a resident of the middle depths. The young are frequently trawled in deep water.

Family GADIDAE

Codfishes

Genus POLLACHIUS Nilsson

Body rather elongate, covered with minute scales; mouth moderate or large, the lower jaw projecting; barbel very small or obsolete; villiform teeth on vomer, none on palatines; teeth in jaws equal or the outer slightly enlarged; gill membranes more or less united; subopercle and postclavicle not enlarged and not ivorylike; dorsal fins three; anal two; caudal lunate; vent under first dorsal. Large fishes of the northern seas.

345 Pollachius virens (Linnaeus)

Pollack

Gadus virens LINNAEUS, Syst. Nat. ed. X, I, 253, 1758.

Gadus purpureus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 370, 1815.

Merlangus purpureus STORER, Rep. Fish. Mass. 130, 1839; DE KAY, N. Y. Fauna, Fishes, 286, pl. 45, fig. 147, 1842; STORER, Hist. Fish. Mass. 180, pl. XXVII, fig. 3, 1867.

Merlangus carbonarius STORER, Rep. Fish. Mass. 129, 1839; DE KAY, N. Y. Fauna, Fishes, 287, pl. 45, fig. 144, 1842.

Merlangus leptocephalus DE KAY, op. cit. 288, pl. 45, fig. 146, Long Island.

Pollachius carbonarius GOODE & BEAN, Bull. Essex Inst. XI, 8, 1879.

Pollachius virens JORDAN & EVERMANN, Check-List Fish. N. A. 493, 1896; BEAN, Bull. Am. Mus. Nat. Hist. IX, 371, 1897; H. M. SMITH, Bull. U. S. F. C. 1897, 107, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2534, 1898; IV, pl. CCCLIX, fig. 886, 1900.

The length of the body is four and one fourth times the depth of the body and four times the length of the head. Body rather elongate, compressed; snout sharp and conic; mouth rather small, oblique; maxillary reaching beyond front of orbit; lower jaw slightly the longer; teeth in upper jaw nearly equal, the outer series not specially enlarged; barbel rudimentary or obsolete; gill membranes considerably united, free from isthmus; vent under first dorsal; caudal fin lunate; pectorals short, scarcely reaching anal; ventrals short. D. 13–22–20; A. 25–20; Lat. l. about 150; vertebrae 54.

Greenish brown above; sides and below somewhat silvery; lateral line pale; fins mostly pale; sometimes a black spot on the axil.

The pollack is a native of the north Atlantic. It is common northward on both coasts, and extends south to France and New Jersey. Mitchill described the fish under the name of the New York pollack. De Kay mentions it under several names: the New York pollack, the coalfish, and the green pollack. De Kay says the fish is taken with the common cod, but is by no means common on the coast of New York. He saw a specimen weighing 17 pounds, and measuring 38 inches in length. In another description he states that the coalfish is often taken off the harbor of New York in company with the cod, and is known as pollack and black pollack. The third form under which the fish was known to De Kay was described by him from a specimen captured by hook out of a large school in Long Island sound. The pollack enters Gravesend bay in the fall. In captivity it is a ravenous feeder. It requires cold water and will not endure high temperatures.

De Kay states that the fish flipped in the same manner as the menhaden, and was at first supposed to be of that species. The school seemed to be very timid; for, on a very slight noise in the boat, they all disappeared.

Dr Smith states that adult pollack appear in Vineyard sound, Great harbor, Woods Hole Mass. in May, following the run of cod. They depart when the temperature of the water reaches 60° or 65°. In April there is a run of pollack, measuring from 1 to 1½ inches long. By June, when these fish leave, they have reached a length of 4 inches. In fall there is a small run of pollack 7 or 8 inches long. The average weight of adults in that locality is about 10 pounds, the largest one seined having weighed 14 pounds. In Massachusetts bay this is an extremely abundant species, and constitutes an important food resource.

Genus MICROGADUS Gill

Very small codfishes allied to Gadus, but with the vent placed before the second dorsal and with a different structure of the cranium. The following is Prof. Gill's account of the skull of Microgadus proximus, the italicised part indicating the difference from Gadus.

The cranium is proportionally broader toward the front and less flattened, while the brain case is flattened below, *decidedly swollen* on each side of a depressed *sphenoidal groove*, and has an ovate cardiform shape: the *paraoccipital* or epiotic is not produced into an angle behind, but is obtusely rounded, and its posterior or *outwardly descending ridge blunt:* the opisthotic is well developed, oblong, and with its reentering angle *high up*, and, on a line with it, the surface is divided into two parts—a *narrow* and flattened one, and a lower, expanded one, much swollen; the alisphenoid or prootic is *oblong*, acutely emarginate in front, swollen from the region of the high anterior sinus, and above a little produced forward; the great *frontal* is a little longer than broad, with supraoccipital crest *continued forward* on the bone, and near the front expanded upward, and with the *expanded portion* behind dividing into narrow *lateral* wings; the lateral testiform ridges of the frontal are continued forward and *curved outward* toward the antero-lateral angles; the anterior frontals are *mostly covered in front* by the great frontal, and are much *developed* in the direction of the antero-lateral angles, the inferior expanded axillary portion being very narrow; the nasal has a rounded ridge in front, continued well below, and its posterior crest is *laminar* and trenchant.

Species American; valued as food.

346 **Microgadus tomcod** (Walbaum)

Tomcod; Frostfish

Gadus tomcod Walbaum, Art. Gen. Pisc. III, 133, 1792.

Gadus tomcodus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 368, 1815; Storer, Rep. Fish. Mass. 126, 1839; Günther, Cat. Fish. Brit. Mus. IV, 331, 1862.

Gadus pruinosus Mitchill, Rep. Fish. N. Y. 4, 1814.

Morrhua pruinosa De Kay, N. Y. Fauna. Fish. 278, pl. 44, fig. 142, 1842; Storer, Hist. Fish. Mass. 179, pl. XXVII, fig. 5, 1867.

Microgadus tomcodus Goode & Bean, Bull. Essex Inst. XI, 8, 1879; Bean, 19th Rep. Comm. Fish. N. Y. 248, pl. III, fig. 3, 1890.

Microgadus tomcod Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 806, 1883; Bean, Bull. Am. Mus. Nat. Hist. IX, 371, 1897; Mearns, Bull. Am. Mus. Nat. Hist. X, 322, 1898; Eugene Smith, Proc. Linn. Soc. N. Y. 1897, 40, 1898; H. M. Smith, Bull. U. S. F. C. 1897, 107, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2540, 1898; IV, pl. CCCLX, fig. 890, 1900; Bean, 52d Ann. Rep. N. Y. State Mus. 109, 1900.

Body subfusiform, moderately robust, its depth slightly less than length of head or about one fifth of the total length; depth of caudal peduncle contained three and one half times in greatest depth of body; snout rounded, the distance from eye to tip of snout twice diameter of eye, the latter being contained five and one half times in length of head; length of maxillary contained two and three fifths times in length of head; mandible much shorter; mandibulary barbel well developed; first dorsal ray inserted over middle of length of pectorals, the distance of this ray from tip of snout being about equal to its distance from end of second dorsal base, the length of the latter being equal to the distance from first dorsal ray to first ray of second dorsal; length of third dorsal base equal to that of second anal, these fins being opposite each other; first anal opposite second dorsal, its base slightly longer; length of pectoral equals base of third dorsal; ventral filamentous, longer than pectoral. 1st D. 13–15; 2d D. 15–19; 3d D. 16–18; 1st A. 18–20; 2d A. 16–20.

Color olive brown with reticulations and blotches of darker; sides and back profusely covered with dark punctulations; under parts lighter; dorsal, caudal and anal fins with dark blotches; pectorals and ventrals dusky.

This fish is very generally known in New York waters under the name of frostfish. It ranges from Nova Scotia to Virginia, and is excessively common in shallow bays in cold weather. The name frostfish is derived from the fact that it appears after frosts have set in. The species ascends fresh-water rivers far above the limits of tide, and may be transferred suddenly from salt water to fresh without inconvenience. It spawns in the early part of winter, and is present at this time in such large numbers as to make its capture with dip nets comparatively easy. The frostfish is the commonest member of the cod family in New York waters. Its size is small, but, from the fact that it occurs in such abundance, it is an important market species. It is subject to great variations in color; Dr Mitchill enumerates among its varieties five forms: the brown, yellow, yellowish white, mixed tomcod and the frostfish. De Kay has published

the statement that he has known the frostfish to be taken out of the water along the shores of Long Island in great numbers with a common garden hoe. He was informed that the species occasionally ascends the Hudson as far as Albany. In Great South bay we found large numbers of tomcod, which were covered with a lernaean parasite. The same thing has been observed frequently at Woods Hole Mass. and other northern localities. We found the species in nearly all parts of the bay late in September in moderate numbers, and more plentiful at Fire Island October 1.

July 29, 1898, a few young tomcod were seined in Peconic bay, near Southampton. In Gravesend bay the fish is a fall and winter visitor. It does not live in captivity in summer. Dr Mearns has found this fish in the Hudson river, where it is usually called frostfish by the fishermen, who catch many of them in their fyke and ice nets during fall and winter. It bites readily and is esteemed as an article of food. Dr Mearns has found it during the entire year, and in August has found young tomcod fully an inch or two in length. He states that this fish is very often found in eel grass along shore, half dead, floating on the surface, but able to swim a little. Mr Eugene Smith says that the tomcod runs up stream into nearly pure fresh water in the vicinity of New York city. At Woods Hole Mass. it is abundant in winter, coming about October 1 and remaining till May 1. It spawns in December. In Massachusetts it is a resident species, entering brackish waters; it is common about the wharves and bridges in summer and is taken with nets and hooks in winter, in company with the smelt.

The tomcod reaches the length of about 10 inches. It is an important food fish and its eggs have been hatched artificially by the New York Forest, Fish and Game Commission in large numbers.

Genus GADUS (Artedi) Linnaeus

Body moderately elongate, compressed and tapering behind; scales very small; lateral line present, pale; head narrowed anteriorly; mouth moderate, the maxillary reaching past front of

eye; chin with a barbel; teeth in jaws cardiform, subequal; vomer with teeth; none on the palatines; cranium without the expanded crests seen in Melanogrammus; no part of the skeleton expanded and ivorylike; dorsal fins three, well separated; anal fins two; ventral fins well developed, of about 7 rays. Species of the northern seas; highly valued as food.

347 Gadus morrhua Linnaeus

Cod

Gadus callarias Linnaeus, Syst. Nat. ed. X, I, 252, 1758, young; Mitchill, Rep. Fish. N. Y. 5, 1814; Trans. Lit. & Phil. Soc. N. Y. I, 367, 1815; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 804, 1883; H. M. Smith, Bull. U. S. F. C. 1897, 107, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2541, 1898; IV, pl. CCCLXI, fig. 891, 1900; Sherwood & Edwards, Bull. U. S. F. C. 1901, 30, 1901.

Gadus arenosus and *rupestris* Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 368, 1815.

Morrhua americana Storer, Rep. Fish. Mass. 120, 1839; De Kay, N. Y. Fauna, Fishes, 274, pl. 44, fig. 140, 1842.

Morrhua americanus Storer, Hist. Fish. Mass. 165, pl. XXVII, fig. 4, 1867.

Gadus morhua Linnaeus, Syst. Nat. ed. X, I, 252, 1758; Mitchill, Rep. Fish. N. Y. 6, 1814.

Gadus morrhua Günther, Cat. Fish. Brit. Mus. IV, 328, 1862; Goode & Bean, Bull. Essex Inst. XI, 8, 1879; Oceanic Ichth. 354, 1896; Bean, Bull. Am. Mus. Nat. Hist. IX, 372, 1897.

Body elongate, robust, its greatest depth one fourth of length to end of vertebral column, tapering to caudal, the depth of the peduncle being less than one fourth of greatest depth of body; the length of the head slightly more than depth of body, one fourth of total length; eye one fifth length of head; maxillary longer than snout, reaching vertical through eye, and contained two and one half times in length of head; teeth moderately strong, in bands; the first dorsal originates behind vertical from base of pectorals, its base equal to length of eye and snout; second dorsal base much longer than first, four fifths length of head; third dorsal and second anal fins similar, their bases of equal length; first anal base almost equal to second dorsal base; caudal emarginate; pectorals and ventrals comparatively small. D. 14, 21, 19; A. 20, 18.

Color olive or yellowish brown; numerous dark brown spots on body; fins dark.

The cod is an inhabitant of the north Atlantic and the north Pacific. It is a very important food fish and grows to a large size. Individuals weighing about 100 pounds have occasionally been taken. Mitchill has described this fish under several names: the torsh, or common cod, or rock cod of New York. De Kay calls it the American cod In November 1897 the cod was abundant in Gravesend bay. It thrives in captivity during the winter and spring, but can not be kept during the warm months without cooling the water. In Vineyard sound, according to Dr Smith, the cod appear about April 1 to about April 15, when the dogfish drive them away. After the middle of October the cod come again but in less numbers than in the spring, remaining till the first wintry weather. The fish spawns during the late fall and winter. The young are first observed at Woods Hole about the first of April, when fish about 1 inch long are seined. Most of the young leave by June 15, having attained a length of from 3 to 4 inches. No cod are seen between small fish of that size and fish weighing from $1\frac{1}{2}$ to 2 pounds, which are caught in traps in the spring. Off the coast of New England cod are very abundant in the deep waters, and they come up to the shoals and near the shores to spawn, from November about Cape Ann till February on Georges banks.

Genus MELANOGRAMMUS Gill

This genus is distinguished from Gadus by its smaller mouth, the produced first dorsal fin, black lateral line, and specially by the great enlargement of the hypocoracoid, which is dense and ivorylike. The lateral line is always black, and the supraoccipital and other crests on the head are largely developed. Food fishes of large size.

348 Melanogrammus aeglefinus (Linnaeus)

Haddock

Gadus aeglefinus Linnaeus, Syst. Nat. ed. X, I, 251, 1758; Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 370, 1815.

Morrhua aeglefinus Storer, Rep. Fish. Mass. 124, 1839; De Kay, N. Y. Fauna, Fishes, 279, pl. 43, fig. 138, 1842; Storer, Hist. Fish. Mass. 177, pl. XXVIII, fig. 1, 1867.

Melanogrammus aeglefinus GILL, Proc. Ac. Nat. Sci. Phila. 280, 1862; GOODE & BEAN, Bull. Essex Inst. XI, 8, 1879; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 803, 1883; GOODE & BEAN, Oceanic Ichth. 354, 1896; BEAN, Bull. Am. Mus. Nat. Hist. IX, 372, 1897; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2542, 1898; IV, pl. CCCLXI, fig. 892, 892a, 1900.

The length of the body is four and one half times its depth and three and three fourths times the length of the head. Snout long and narrow, overlapping the small mouth; maxillary barely reaching front of orbit; teeth subequal, large, in a cardiform band in upper jaw; in a single series on lower jaw and on vomer; occiput carinated; a ridge extending backward from each orbit; eye very large, two thirds length of snout, four in head. Anterior rays of first dorsal elevated, three fourths length of head, the fin pointed, higher than second and third dorsals; caudal lunate; vent below front of second dorsal. The skull in this species much more depressed than in G a d u s c a l l a r i a s, broader, and thinner in texture; occipital crest exceedingly high, much higher than in G a d u s, the winglike projections at its base anteriorly spreading widely, raised above the surface of the skull. D. 15–24–21; A. 23–21.

Dark gray above, whitish below; lateral line black; a large dark blotch above the pectorals; dorsals and caudal dusky.

Mitchill described the haddock under the name G a d u s a e g l e f i n u s. De Kay also describes the fish and gives a figure of it in his *New York Fauna*. He states that it is nearly as common in the New York markets as the cod, and during the summer it is even more abundant than the cod.

The haddock inhabits the north Atlantic on both coasts, ranging south to France and to North Carolina. Off Cape Hatteras it occurs in the deeper water. It is an important food fish, and reaches a moderately large size, attaining to a length of nearly 3 feet.

At Woods Hole Mass. it was reported by Prof. Baird in 1871. Dr Smith, however, says it is not found in Vineyard sound or Buzzards bay, but is common 6 or 7 miles off Gay head, and the ocean side of Marthas Vineyard. In Massachusetts bay it is a common resident species.

Genus LOTA (Cuvier) Oken

Body long and low, compressed behind; head small, depressed, rather broad; anterior nostrils each with a small barbel; chin with a long barbel; snout and lower parts of head naked; mouth moderate, the lower jaw included; each jaw with broad bands of equal, villiform teeth; vomer with a broad, crescent-shaped band of similar teeth; no teeth on palatines; gill openings wide, the membrane somewhat connected, free from the isthmus; scales very small, embedded; vertical fins scaly; dorsal fins two, the first short, the second long, similar to the anal; caudal rounded, its outer rays procurrent; ventrals of several rays. One or two species, living in fresh waters of northern regions.

349 Lota maculosa (Le Sueur)

Burbot; Lawyer; Ling

Gadus maculosus LE SUEUR, Jour. Ac. Nat. Sci. Phila. I, 83, 1817, Lake Erie.

Gadus lacustris MITCHILL, Am. Month. Mag. II, 244, February, 1818.

Lota brosmiana STORER. Bost. Jour. Nat. Hist. IV, pl. 5, fig. 1, 1839.

Lota inornata DE KAY, N. Y. Fauna, Fishes, 283, pl. 45, fig. 145, 1842. Hudson River.

Gadus compressus LE SUEUR, Jour. Ac. Nat. Sci. Phila. I, 84, 1817.

Lota compressa DE KAY, op. cit. 285, pl. 78, figs. 244, 245, 1842.

Molva maculosa LE SUEUR, Mém. Mus. Paris, V, pl. 16, 1819.

Lota maculosa DE KAY, op. cit. 284, pl. 52, fig. 168, 1842; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 804, 1883; MEEK, Ann. N. Y. Ac. Sci. IV, 315, 1888, Cayuga Lake; BEAN, Fishes Penna. 138, pl. 35, fig. 75, 1893; EVERMANN & KENDALL, Rept. U. S. F. C. 1894, 603, 1896; BEAN, Bull. Am. Mus. Nat. Hist. IX, 372, 1897, Canandaigua Lake; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2550, 1898; IV, pl. CCCLXIV, fig. 897, 1900.

The body of the burbot is elongate, eel-shaped; its greatest hight equaling the length of head without snout, and about one sixth of total without caudal; it is roundish, somewhat compressed posteriorly. The eye is small, less than one half length of snout and about one eighth length of head. The upper jaw reaches slightly beyond the hind margin of the eye, its length three sevenths length of head. The lower jaw is included within the upper, and has a stout barbel which is nearly one fifth as long as the head; the ventral is longer than the pectoral,

but does not reach half way to vent; the pectoral is half as long as the head; the distance of the first dorsal from the head equals the hight of the body; the longest ray of the first dorsal equals half the length of its base; the dorsal fins are separated by a narrow interspace; the second dorsal is higher than the first, and the length of its base is nearly one half total without caudal; the anal begins under the ninth ray of the second dorsal and extends as far back as that fin; caudal rounded; the scales are deeply embedded in the skin, not imbricated. D. 13, 68 to 76; A. 67; V. 7; vertebrae, 22 to 23+38 to 39; pyloric caeca, 30 to 138.

The color is dark olivaceous, reticulated with blackish; the lower parts yellowish or dusky; the dorsal, anal and caudal fins with a narrow dark edge.

The American burbot was first described by Le Sueur from Lake Erie in 1817, and also from Northampton Conn. under a different name. This common fish has received a great many names, including the following: marthy, methy, losh, eelpout, dogfish, chub eel, ling, lawyer, lake cusk, fresh-water cod, aleby trout and mother-of-eels.

The southern limit of this fish appears to be Kansas City Mo.; according to Prof. Cope, it has been once taken in the Susquehanna near Muncy, Lycoming co.; it is extremely common in the Great lakes; westward it ranges to Montana and northward throughout British Columbia and Alaska to the Arctic ocean; it is most abundant in the Great lakes and lakes of New York, New England and New Brunswick; it abounds also in rivers and lakes of Alaska.

The burbot was sent from Canandaigua lake by Mr James Annin jr in November 1897. It is hard to transport and still harder to keep alive in captivity, being specially liable to attacks of fungus.

Dr W. M. Beauchamp, writing from Baldwinsville N. Y. Ap. 9, 1879, said that the burbot is found in Seneca river and is abundant in Oneida lake; that it is caught with a hook and is seldom eaten, though there is a way of making it palatable.

According to Dr Meek it is found rarely in Cayuga lake.

The average length of this species in the Great lakes region is about 2 feet; in Alaska, according to Dr Dall, it reaches a length of 5 feet and occasionally weighs 60 pounds; the size of the fish depends chiefly on the amount of food accessible to it.

It is stated that the burbot is usually found in deep water on mud bottom, except during the spawning season, in March, when it frequents hard or rocky bottoms. The eggs are small and numerous, and are believed to be deposited in deep water; Dr Dall estimates that some individuals contain several millions of eggs; in Alaska the eggs are of a creamy yellow color, and the fish are found full of spawn from November to January. From the observations mentioned, it will be seen that the spawning period extends at least from November to March; according to Dr Dall the males are usually much smaller than the females and have a smaller liver; in some males he found two or three gall bladders opening into a common duct, but he never observed this phenomenon in the female; the eggs are laid separate or loose on the bottom of the river. According to Baron Cederström, a medium-sized female of the European burbot, which is a near relative of the American species, contained about 160,000 eggs; in the European burbot, some eggs are clear, some yellowish and others almost colorless; the period of incubation occupies from three to four weeks; the eyes appear in 15 or 16 days; the embryos swim by quick movements of the pectorals, usually toward the surface of the water, whence they fall passively to the bottom.

The burbot is extremely voracious, and feeds on bottom fishes and crustaceans. It destroys the pike and such spiny fishes as the yellow perch and sunfish. In Alaskan rivers it feeds on whitefish, lampreys and other species; large stones have sometimes been found in its stomach. Mr Graham took a stone weighing a pound from the stomach of a burbot.

In the Great lakes region the burbot is considered worthless for food, occasionally the livers are eaten; in Lake Winnepe-

saukee, when caught through the ice in winter, the fish is highly esteemed; in the fur countries the roe is an article of food; on the Yukon river the liver is eaten and the flesh is liked by some persons; in Montana the burbot is in great demand for food; the quality of the flesh appears to depend chiefly on the nature of the habitat of the fish.

This is the only member of the cod family permanently resident in the fresh waters of America.

Genus UROPHYCIS Gill

Body rather elongate; head subconic; mouth rather large, the maxillary reaching to below eye; lower jaw included; chin with a small barbel; jaws and vomer with broad bands of subequal, pointed teeth; palatines toothless; dorsal fins two, the first sometimes produced at tip; second dorsal long, similar to the anal; ventrals wide apart, filamentous, each of three slender rays closely joined, appearing like one bifid filament; gill membranes somewhat connected, narrowly joined to the isthmus.

Subgenus UROPHYCIS

350 Urophycis regius (Walbaum)

Spotted Codling; Spotted Hake

Blennius regius WALBAUM, Art. Gen. Pisc. III, 186, 1792.

Gadus punctatus MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 372, pl. I, fig. 5, 1815, New York; DE KAY, N. Y. Fauna, Fishes, 292, pl. 46, fig. 149, 1842.

Phycis regalis GÜNTHER, Cat. Fish. Brit. Mus. IV, 354, 1862.

Phycis regius GOODE & BEAN, Bull. Essex Inst. XI, 8, 1879; Oceanic Ichth. 357, 1896; BEAN, Bull. Am. Mus. Nat. Hist. IX, 372, 1897; H. M. SMITH, Bull. U. S. F. C. 1897, 107, 1898.

Urophycis regius GILL, Proc. Ac. Nat. Sci. Phila. 240, 1863; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2553, 1898; IV, pl. CCCLXIV, fig. 898, 1900.

The depth of the body is contained four and one half times in its length, which is four and one fourth times the length of the head. Body rather stout; head broad; mouth large, the maxillary reaching posterior margin of eye; eye less than snout or interorbital width; first dorsal low, its hight about equal to half length of head; ventral fin longer than head, about three and one half in the length of the body; caudal fin subtrun-

cate. D. 8–43; A. about 45; scales rather large, about 90 in the lateral line.

Pale brownish, tinged with yellowish, the lateral line dark brown, interrupted by white spots; inside of mouth white; first dorsal largely black, this color surrounded by white; second dorsal olivaceous, with irregular, round, dark spots; caudal, anal and pectorals dusky; ventrals and lower edge of pectorals white; two vertical series of round dark spots on the sides of the head.

Mitchill described and figured the spotted codling under the name of Gadus punctatus. De Kay called it the spotted codling, Phycis punctatus, and he gives a good figure of it. His example was 10 inches long. He says it is an exceedingly rare but distinct species, and that it occurs from the coast of New York to the Gulf of St Lawrence. As a matter of fact, the species extends even farther north. The codling ranges southward to Cape Fear. In the northern part of its habitat it is found in shallow water, but at the southern limit it lives in considerable depths, having been taken from 167 fathoms. The fish is said to exhibit electrical powers in life.

The spotted codling appears in Gravesend bay in small numbers in the fall. It lives in water below 60° F., and is easily kept in captivity by refrigerating the water in summer. Its habit of lying on the side, in imitation of the tautog and other labroïds is often observed. Prof. Alexander Agassiz discovered electric powers in this fish.

At Woods Hole Mass., according to Dr Smith, it is taken in the seine only late in the fall. It varies in length from 7 to 12 inches. The species has been observed at Halifax N. S.

Subgenus EMPHYCUS Jordan & Evermann

This subgenus differs from Urophycis in having the first dorsal fin elevated, with one or more of its rays filamentous.

351 Urophycis tenuis (Mitchill)

Hake; White Hake

Gadus tenuis MITCHILL, Rep. Fish. N. Y. 5, 1814; Trans. Lit. & Phil. Soc. N. Y. I. 372, 1815. New York.

Phycis tenuis De Kay, N. Y. Fauna, Fishes, 293, 1842; Goode & Bean, Bull. Essex Inst. XI, 8, 1879; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 799, 1883; Bean, 19th Rep. Comm. Fish. N. Y. 248, pl. III, fig. 4, 1890; Goode & Bean, Oceanic Ichth. 359, fig. 312, 1896; Bean, Bull. Am. Mus. Nat. Hist. IX, 372, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 107, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2555, 1898; IV, pl. CCCLXV, fig. 901, 1900; Bean, 52d Ann. Rep. N. Y. State Mus. 109, 1900.

The length of the body is five and one half times the depth of the body and four and one fourth times the length of the head. Snout longer than eye, narrower and more pointed than in P. chuss. Eye large, usually wider than interorbital space; maxillary reaching beyond pupil; filamentous dorsal ray about two thirds length of head; ventral fins about reaching vent; scales very small. D. 9–57; A. 48; Lat. l. 138.

Brownish, lighter and yellowish below; fins very dark. Distinguished from U. chuss chiefly by the smaller scales.

De Kay calls the hake the American codling, adopting Mitchill's common name for the species. He says it appears to feed chiefly on smaller crustacea; that it is very abundant at some seasons, but most abundant in the early part of autumn; and varies in weight from 3 pounds to 30 pounds. He states that it is called indiscriminately hake and codling by New York fishermen. Small individuals were seined in Mecox bay Aug. 2, 1898, and a very young example was received from Southampton Sep. 11. This was caught in the Atlantic. In Great South bay small examples were found sparingly at Blue Point cove and Fire Island late in September.

The hake, according to Dr Smith, is known also as white hake and squirrel hake in the vicinity of Woods Hole Mass. Fish weighing 1 to 1½ pounds are abundant there in November, when a great many of them enter Eel pond. Young fish 1 inch long and upward associate with pollack in spring and are also found throughout the summer in considerable numbers. They are also obtained in summer at the surface, under gulf weed and eel grass.

As a rule the common hake will not live in water of a temperature above 60°F, but one individual survived the summer tem-

perature in 1897, and became plump and sleek after the arrival of cold weather. In summer it was much emaciated, and suffered greatly from fungus attacks.

It is abundant on our shores from Labrador to Virginia, and its young are among the commonest of the surface fishes in our bays and sounds, during the summer months. The hake reaches a weight of 40 pounds, but in the markets the average weight is only about 10 pounds. The species frequents muddy bottoms and is local in its habits. Its food consists of crabs and other crustaceans, besides small fishes.

The chief fishery for hake takes place in the fall and winter months, and they will take the hook at night as well as during the day. Trawl lines are the usual implements of capture.

352 **Urophycis chuss** (Walbaum)

Squirrel Hake

Blennius chuss WALBAUM, Art. Gen. Pisc. III, 186, 1792.

Gadus longipes MITCHILL, Rep. Fish. N. Y. 5, 1814; Trans. Lit. & Phil. Soc. N. Y. I, 372, pl. I, fig. 4, 1815, New York.

Phycis filamentosus STORER, Hist. Fish. Mass. 189, pl. XXIX, fig. 4, 1867.

Phycis chuss GILL, Proc. Ac. Nat. Sci. Phila. 237, 1863; GOODE & BEAN, Bull. Essex Inst. XI, 8, 1879; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 799, 1883; GOODE & BEAN, Oceanic Ichth. 359, fig. 311, 1896; BEAN, Bull. Am. Mus. Nat. Hist. IX, 372, 1897; H. M. SMITH, Bull. U. S. F. C. 1897, 107, 1898.

Urophycis chuss JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2555, 1898; IV, pl. CCCLXV, fig. 902, 1900.

The depth of the body is one fifth of its length, which is four and one half times the length of the head. Body rather slender; head depressed; eye large, about equal to interorbital width; maxillary reaching posterior margin of pupil; filamentous dorsal ray about two sevenths length of body, when perfect; pectorals four fifths length of head; ventral fin extending beyond the vent; scales comparatively large. D. 9–57; A. 50; Lat. 1.110.

Brownish above, sides lighter and tinged with yellowish; thickly punctulate with darker; below pale; inside of mouth white; vertical fins somewhat dusky; anal fin margined with pale; lateral line not dark.

According to Jordan and Evermann, this fish is sometimes called codling. It inhabits the Atlantic coast from the Gulf of

St Lawrence to Virginia, being very common northward. It is sometimes found in waters as deep as 300 fathoms. The squirrel hake occurs occasionally in Gravesend bay; it lives usually in the deep water off shore.

At Woods Hole Mass. according to Dr Smith, it is abundant in May and June, and in October and November. It fills the traps and causes the fishermen much annoyance, as they can not sell the fish. Its weight there is from 2 to 5 pounds. In Massachusetts bay it is less abundant than the common hake. It was described and figured by Storer in 1867, under the name Phycis filamentosus.

Genus GAIDROPSARUS Rafinesque

Body rather elongate, covered with minute scales; head not compressed, the upper jaw the longer; snout with two conspicuous barbels, the chin with one; teeth on jaws and vomer in bands, palatines toothless; dorsals two, the anterior of a single long ray followed by a series of short fringelike rays concealed in a groove; second dorsal and anal long, similar to each other; caudal rounded or lanceolate; ventral rays 5 to 7. Small fishes of the northern seas, descending to deep water.

353 Gaidropsarus argentatus (Reinhardt)

Silvery Rockling; Mackerel Midge

Motella argentata REINHARDT, Dansk. Vidensk. Selskrift. Afh. VII, 128, 1838, Greenland.

Couchia argentata GÜNTHER, Cat. Fish. Brit. Mus. IV, 365, 1862.

Ciliata argentata GILL, Proc. Ac. Nat. Sci. Phila. 241, 1863.

Onos reinhardti GILL, op. cit. 241, 1863; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 797, 1883; GOODE & BEAN, Oceanic Ichth. 383, 1896.

Gaidropsarus argentatus JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2559, 1898; IV, pl. CCCLXVII, fig. 906, 1900.

The length of the body is five times the length of the head. Head depressed, but rather pointed anteriorly; snout rather short, with two barbels; chin with one; teeth in villiform bands, those of one series in each jaw longer than the rest; first ray of first dorsal short, little longer than snout; vent near middle of length; distance from snout to first dorsal three tenths of length. D. 56; A. 45; V. 8.

Uniform reddish brown; cirri and tips of fins red. Greenland.

The silvery rockling, or mackerel midge, inhabits the coast of Greenland, and extends southward probably as far as Long Island, the young having been taken in Vineyard sound.

354 Gaidropsarus ensis (Reinhardt)

Rockling

Motella ensis Reinhardt, Dansk. Vidensk. Selskrift. Afh. VII. 15, 1838, Greenland.

Onos rufus Gill, Proc. U. S. Nat. Mus. 259, 1883, Gulf Stream; Proc. Ac. Nat. Sci. Phila. 172, 1884.

Onos ensis Gill, Proc. Ac. Nat. Sci. Phila. 241, 1863; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 797, 1883; Goode & Bean, Oceanic Ichth. 381, fig. 327, 1896.

Gaidropsarus ensis Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2558, 1898.

Body unusually deep, its greatest depth at vent equaling two ninths of total length without caudal; head small, a little more than one sixth of total without the caudal; eye rather large, nearly as long as snout, equaling interorbital area, and situated in first half of head; posterior margin of orbit nearly equidistant from tip of snout and posterior margin of opercle; mouth normal; supramaxillary ending under posterior margin of pupil; teeth in a narrow band in each jaw, some of those at least in outer row of upper jaw slightly enlarged and brownish colored; vomerine teeth in two rows forming a short curved band; nasal barbel about equal to diameter of eye; chin barbel small and not much exceeding one half diameter of eye; foremost ray of first dorsal springing from back above opercular margin; second dorsal fin low in front, but rising rapidly to seventh or eighth ray, behind which it is nearly uniform for a long distance and highest at posterior portion; anal fin much lower than second dorsal; caudal slightly emarginate, almost truncate behind, its median rays about two thirds as long as the head; pectorals nearly three fourths as long as the head, produced toward the upper angles, the third ray being longest; ventrals with their bases mostly in advance of pectorals, the longest ray filamentous and nearly equaling pectoral; lateral line obsolescent. D. 59; A. 44 to 46; P. 22 to 27; V. 8.

Inhabits the Atlantic coast of North America from Greenland to Cape Hatteras in deep waters. It reaches a depth in the Gulf Stream of 1081 fathoms. The fish is described and figured by Goode and Bean in *Oceanic Ichthyology*, p. 381, fig. 327. It is a small species, scarcely reaching 1 foot in length, and is without importance as food.

Genus ENCHELYOPUS Bl. & Schn.

Barbels four, one at each nostril, one at tip of snout, and one at the chin; head high and compressed anteriorly; teeth in narrow bands, some of them enlarged; otherwise essentially as in Gaidropsarus. North Atlantic.

355 Enchelyopus cimbrius (Linnaeus)

Four-bearded Rockling

Gadus cimbrius LINNAEUS, Syst. Nat. ed. XII. I, 440, 1766, Atlantic Ocean.
Motella caudacuta STORER, Hist. Fish. Mass. 183, pl. XXIX, fig. 1, 1867.
Onos cimbrius JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 797, 1883.
Rhinonemus cimbrius GOODE & BEAN, Oceanic Ichth. 384, fig. 328, 1896; H. M. SMITH, Bull. U. S. F. C. 1897, 107, 1898; SHERWOOD & EDWARDS, Bull. U. S. F. C. 1901, 31, 1901.
Enchelyopus cimbrius JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2560, 1898; IV, pl. CCCLXVII, fig. 907, 1900.

Body slender, tapering, its depth nearly one sixth of the total without caudal; caudal peduncle narrow, one fourth length of head, which is contained five and one half times in total without caudal; snout moderate, blunt, rounded, not depressed, a little shorter than the eye, which is one fourth as long as the head; interorbital space narrow, one sixth length of head; teeth villiform, small and unequal in upper jaw, with about eight enlarged in front, long, slender, and equal in lower jaw, a few somewhat enlarged in front; maxillary reaching beyond posterior border of eye; a barbel at each nostril, one on tip of snout and one on chin; lateral line with about 35 enlarged pores along its entire length; first (free) ray of dorsal nearly as long as the head; ventral one half as long as head; pectoral equal to head without snout; caudal narrow, rounded behind, two thirds as long as head.

Color, light rufous or salmon red; first dorsal ray and posterior end of dorsal and anal abruptly black; lower half of caudal

black; pectorals and ventrals pale; sides of head somewhat silvery; cavity of mouth dark bluish.

The four-bearded rockling is found in the north Atlantic on both coasts, ranging south in deep water to the Gulf Stream. It is common in Massachusetts bay. This fish is also described in *Oceanic Ichthyology*, p. 384, fig. 328. At Woods Hole Mass., according to Dr Smith, it is a rare visitor, found only in winter. It was once taken in a fyke net in Great harbor. In 1900, according to Sherwood and Edwards, young rockling were taken in the surface towings at the fish commission wharf, Woods Hole Mass. from June 27 to July 6. They formed into schools in the eddies, around the wharves and were mixed with young sticklebacks. An example measuring 10 inches in length was speared in the Eel pond Jan. 5, 1889. A second example was caught in Little harbor also in the winter.

Storer described and figured this fish under the name Motella caudacuta. It is a resident of the deep waters of Massachusetts bay, where it occurs in considerable abundance. The young swim at the surface and have often been erroneously identified with the mackerel midge. The species grows to the length of 1 foot.

Genus BROSME (Cuvier) Oken

Body moderately elongate, covered with very small scales; mouth rather large, with teeth in the jaws, vomer and palatines, some of those on the vomer and palatines enlarged; chin with a barbel; branchiostegals seven; dorsal fin single, continuous, not elevated, not notched; anal fin similar, but shorter; caudal fin rounded; ventral fin several-rayed. Northern seas.

356 Brosme brosme (Müller)

Cusk

Gadus brosme MÜLLER, Prodr. Zool. Dan. 41, 1776, Denmark.

Brosmius vulgaris? DE KAY, N. Y. Fauna, Fishes, 289, pl 44, fig. 143, 1842.

Brosmius flavescens GÜNTHER, Cat. Fish. Brit. Mus. IV, 369, 1862; STORER, Hist. Fish. Mass. 190, pl. XXIX, fig. 2, 1867.

Brosmius brosme GÜNTHER, op. cit. IV, 369, 1862; GOODE & BEAN, Bull. Essex Inst. XI, 9, 1879; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 802, 1883; GOODE & BEAN, Oceanic Ichth. 385, fig. 329, 1896; H. M. SMITH, Bull. U. S. F. C. 1897, 107, 1898.

Brosme brosme JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2561, 1898.

Body cylindric, posteriorly compressed, its depth contained five and one fourth times in total length without caudal; head flattened above, its length contained four and one fourth times in total; mouth large, oblique, maxillary reaching beyond orbit; lower jaw included; several rows of sharp teeth on jaws, vomer and palate; barbel about one fifth as long as the head; interorbital width greater than diameter of eye; origin of dorsal above anterior half of pectoral; pectoral round, two fifths as long as head; caudal rounded behind. D. 98; A. 71; P. 24; V. 5.

Color brownish above, the sides yellowish, sometimes mottled with brown; young uniform dark slate, or with transverse yellow bands; vertical fins bordered with blackish, and with a white edge.

The cusk is described and figured by De Kay, but he did not see the fish and copied his information from Storer and others. Storer mentions a specimen weighing 20 pounds, but the fish grows even larger. It inhabits the North Atlantic, ranging southward to New Jersey and Denmark. It is an important food fish. According to Dr Smith, it was formerly not uncommon in Vineyard sound, and was caught with cod in April and May. It has been very rare for more than 20 years, though a few are still taken in April. The average weight of individuals in those waters is 5 pounds, and the maximum weight from 12 to 13 pounds. It is known also as ling. In Massachusetts bay and vicinity the cusk is a common resident on the inshore fishing grounds, where it occurs in great abundance, lurking among the stones, but it is soon caught up by the fishermen after the discovery of a new bank.

Family MACRURIDAE

Grenadiers

Genus COELORHYNCHUS Giorna

This genus agrees with Macrurus in all essential respects, except that the small mouth is wholly below the long-pointed, sturgeonlike snout. Dorsal spine smooth in typical species, those with serrate spine having been lately separated under the generic name Coelocephalus. Species numerous.

357 Coelorhynchus carminatus (Goode)

Grenadier

Macrurus carminatus Goode, Proc. U. S. Nat. Mus. III, 346, 475, 1880.
Macrurus (Coelorhynchus) carminatus Günther, Challenger Report, Deep-sea Fishes, XXII, 129, pl. 5, fig. 13, 1887.
Coelorhynchus carminatus Goode & Bean, Oceanic Ichth. 398, fig. 336, 1896; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2588, 1898; IV, pl. CCCLXIX, fig. 914, 1900.

The body is stout anteriorly, tapering very rapidly to a rather long and slender tail. The depth is one eighth, and the length of the head about one fifth of the total length. The eye is large, one fifth as long as the head, equaling the interorbital width. The snout is as long as the eye. The body is less elongate than in Baird's grenadier. The snout is long, sharp, depressed, triangular. Strong horizontal ridges run from the supraorbital margins to the gill openings, parallel with the subocular ridges. The nostrils are immediately in front of the orbit; barbel very short; teeth small, conic, somewhat recurved, arranged in villiform bands; base of first dorsal fin two ninths as long as the distance from its origin to the snout. The first dorsal spine is very short, hardly perceptible above the skin. The second spine is about one half as long as the head, slender and unarmed; when laid back, the tip reaches to or beyond the origin of the second dorsal. The spines decrease in length very gradually, the sixth being nearly as long as the second. The second dorsal begins in the perpendicular from the seventh anal ray. The anal fin is much higher than in Baird's grenadier, nearly equal to one half of the interorbital width; its origin is under the 18th scale of the lateral line; its longest ray is as long as the interorbital width. The distance of pectoral from snout equals twice its own length, and about equals the longest dorsal spine; the origin of the pectoral is below the middle of the depth of the body, and below the level of the middle of the orbit; the tip of the pectoral does not reach the origin of the anal. The insertion of the ventrals is behind the pectoral, slightly in advance of the first dorsal, its distance from the snout greater than twice its length, its long filament not reaching the anal. Color silvery gray. Length of the specimen described 10 inches.

This grenadier inhabits the West Indies, the Gulf of Mexico, and is found in the Gulf Stream in deep water. It is abundant. The U. S. Fish Commission steamer, *Fish Hawk*, has taken it in the Gulf Stream off Rhode Island in 115 fathoms. The fish is described and figured by Goode and Bean, *Oceanic Ichthyology*, p. 398, fig. 336.

Order HETEROSOMATA

Flatfishes

Family PLEURONECTIDAE

Flounders

Genus HIPPOGLOSSUS Cuvier

Eyes and color on the right side; form oblong, not strongly compressed; mouth wide, oblique; teeth in the upper jaw in two series, those below in one, anterior teeth in upper jaw, and lateral teeth in lower, strong, no teeth on vomer or palatines, lower pharyngeal teeth in two rows; dorsal fin beginning above the eye, its middle rays elevated, the posterior rays of dorsal and anal bifid; caudal fin lunate; ventral fins both lateral; scales very small, cycloid; lateral line with a strong curve in front; gill rakers few, short, compressed, wide set. Vertebrae 16+34. Largest of the flounders. One species; abundant on both coasts of the north Atlantic and of the north Pacific.

358 Hippoglossus hippoglossus (Linnaeus)

Halibut

Pleuronectes hippoglossus LINNAEUS, Syst. Nat. ed. X, I, 269, 1758; MITCHILL, Rep. Fish. N. Y. 10, 1814; Trans. Lit. & Phil. Soc. N. Y. I, 386, 1815.

Hippoglossus vulgaris DE KAY, N.Y. Fauna, Fishes, 294, pl. 49, fig. 157, 1842; GÜNTHER, Cat. Fish. Brit. Mus. IV, 403, 1862; STORER, Hist. Fish. Mass. 192, pl. XXX, fig. 1, 1867; GOODE & BEAN, Bull. Essex Inst. XI, 7, 1879; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 819, 1883; GOODE, Fish & Fish. Ind. U. S. I, 189, pl. 54, 1884.

Hippoglossus hippoglossus JORDAN, Cat. Fish. N. A. 133, 1885; H. M. SMITH, Bull. U. S. F. C. 1897, 108, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2611, 1898; IV, pl. CCCLXXI, fig. 918, 1900; SHERWOOD & EDWARDS, Bull. U. S. F. C. 1901, 31, 1901.

Body comparatively elongate, not strongly compressed, deep mesially, its depth one third of total length without caudal, tapering rapidly in its posterior half; head broad, moderately

long, its length contained three and three fourths times in total length without caudal; mouth large, the maxillary reaching to below middle of orbit; eyes large, separated by a very broad, flattish area; lower eye slightly in advance. D. 105; A. 78; P. 19; V. 6.

Color, nearly uniform dark brown, blind side white.

The halibut lives in all northern seas, ranging southward to Sandy Hook, or beyond, and occasionally to the Farallones off San Francisco.

The halibut was described by both Mitchill and De Kay under its present name. De Kay says that the capture of the halibut on the shores of Nantucket at one time afforded employment to 80 vessels of from 60 to 80 tons each. He says the fish is very voracious, swimming near the ground and devouring other flat fishes as well as shells and crustaceans. It occurs on both shores of the Atlantic as also in the north Pacific, migrating south on the approach of spring and returning in June or July. An individual was found some years ago near Colonial Beach, in the Potomac river. The fish grows to the length of 8 feet or more, and the weight of several hundred pounds. It is a very valuable food fish. In the Pacific, according to Jordan and Evermann, it extends its range southward to the Farallones, off San Francisco.

The halibut was formerly not very uncommon in Vineyard sound, where it is now very rare. In 1872 and 1873, V. N. Edwards caught a number weighing 235 or 240 pounds while fishing for cod. Ap. 16, 1900, a halibut weighing 100 pounds was caught off Block island by cod fishermen, and was taken to Newport. The fish was very abundant at one time in Massachusetts bay, but is now found chiefly in depths of 100 to 250 fathoms on the slopes of the outer banks. In August 1878 a halibut weighing over 200 pounds was caught in Gloucester harbor.

Genus HIPPOGLOSSOIDES Gottsche

Eyes and color on the right side (except sometimes in H. elassodon, a Pacific species); body oblong, moderately compressed; mouth rather large, with one row of sharp teeth on each jaw; no teeth on vomer or palatines; gill rakers rather

long and slender; scales ctenoid; lateral line nearly straight, simple; dorsal fin low in front, beginning over or before the eye; ventrals both lateral; caudal double truncate, produced behind. This genus, as here restricted, contains three closely related species, two of the north Pacific, one of the north Atlantic. All are essentially arctic species, inhabiting shallow waters in the regions where they are most abundant.

359 Hippoglossoides platessoides (Fabricius)

Rough Dab

Pleuronectes platessoides FABRICIUS, Fauna Groenlandica, 164, 1780, Greenland.

Platessa dentata STORER, Rep. Fish. Mass. 143, 1839; Hist. Fish. Mass. 197, pl. XXX, fig. 3, 1867; DE KAY, N. Y. Fauna, Fishes, 298, 1842, New York markets.

Hippoglossoides dentatus GÜNTHER, Cat. Fish. Brit. Mus. IV, 406, 1862.

Hippoglossoides platessoides GILL., Proc. Ac. Nat. Sci. Phila. 217, 1864; GOODE & BEAN, Bull. Essex Inst. XI, 7, 1879; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 826, 1883; GOODE, Fish & Fish. Ind. U. S. I. 197, pl. 55, 1884; GOODE & BEAN, Oceanic Ichth. 438, 1896; H. M. SMITH, Bull U. S. F. C. 1897, 108, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2614, 1898; IV, pl. CCCLXXII, fig. 919, 1900.

The length of the body is two and one half times its depth and three and three fourths times the length of the head. Body ovate; mouth moderate, oblique; maxillary narrow, reaching to beyond pupil, two and two thirds in length of head; teeth rather small, conic, larger anteriorly, in one row in each jaw, those in the lower largest; eyes rather large, the upper longer than snout, four and one third in head; lower jaw included, but with a projecting knob at the chin; snout thick and scaly; interorbital space narrow, with a raised obtuse ridge, entirely covered with rough scales in about six series; mandible with a series of scales; gill rakers rather short and robust, not toothed, about 10 below angle; longest raker less than one third length of eye; fins with small, rough scales; a strong preanal spine; pectoral not quite half length of head. D. 88 (80 to 93); A. 70 (64 to 75); Lat. 1.90 (pores).

Reddish brown, nearly plain. North Atlantic; abundant northward on both coasts.

De Kay described this flounder under the name of the toothed flatfish. He said it was extremely common in New York markets, where it is called the summer flounder, and that it grows to the length of 25 inches. It is a rather common food fish of the deep waters northward on both sides of the north Atlantic, ranging habitually south to Cape Cod and the coasts of England and Scandinavia. At Woods Hole it is sometimes called sand dab and rusty flounder. Dr Smith says it is not common there, but is found some years in winter in inshore waters adjacent to Woods Hole; specimens have been taken in February on lines. One year some were caught in a fyke net in Great harbor. In Massachusetts bay it is a common species in the deep waters, approaching the shores in winter.

Genus PARALICHTHYS Girard

Eyes and color normally on the left side; body oblong; mouth large, oblique; each jaw with a single row of usually slender and sharp teeth, which are more or less enlarged anteriorly, no teeth on vomer or palatines; gill rakers slender; scales small, weakly ctenoid or ciliated; lateral line simple, with a strong curve anteriorly; dorsal fin beginning before the eye, its anterior rays not produced; both ventrals lateral; caudal fin double truncate, or double concave, its middle rays produced; no anal spine. Species numerous, found in all warm seas. This genus, as now restricted, contains a considerable number of species, inhabiting both coasts of America and the eastern and southern coasts of Asia. As indicated by the reduced number of vertebrae, the species range farther southward than do those of the type of Hippoglossoides.

360 **Paralichthys dentatus** (Linnaeus)

Summer Flounder

Pleuronectes dentatus LINNAEUS, Syst. Nat. ed. XII, I, 458, 1766; MITCHILL, Trans. Lit. & Phil. Soc. N. Y. I, 390, 1815.
Pleuronectes melanogaster MITCHILL, op. cit. 390, 1815, New York.
Platessa ocellaris DE KAY, N. Y. Fauna, Fishes, 300, pl. 47, fig. 152, 1842.
Pseudorhombus ocellaris GUNTHER, Cat. Fish. Brit. Mus. IV, 430, 1862.
Platessa oblonga STORER, Hist. Fish. Mass. 201, pl. XXXI, fig. 2, 1867.
Pseudorhombus dentatus GOODE & BEAN, Bull. Essex Inst. XI, 7, 1879.

Paralichthys ophryas JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 822, 1883.
Paralichthys dentatus GOODE, Fish & Fish. Ind. U. S. I, 178, 1884 (part); JORDAN, Cat. Fish. N. A. 134, 1885; BEAN, 19th Rep. Comm. Fish. N. Y. 246, pl. II, fig. 2, 1890; Bull. Am. Mus. Nat. Hist. IX, 372, 1897; H. M. SMITH, Bull. U. S. F. C. 1897, 108, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2629, 1898; IV, pl. CCCLXXIII, fig. 922, 1900; BEAN, 52d Ann. Rep. N. Y. State Mus. 110, 1900.

The depth of the body is contained two and one third times in its length, which is three and two thirds times the length of the head. Body oblong, moderately compressed; mouth wide, oblique, the mandible very heavy and much projecting; eight to 10 teeth on side of lower jaw, the two anterior teeth very long; anterior teeth of upper jaw strong, but smaller than those in the lower jaw; the lateral teeth very small and close set; eyes small, shorter than snout, about one sixth length of head, and in adult as wide as the broad, flattish, scaly interorbital area. The latter is much narrower in the young. Scales small, cycloid; accessory scales few; gill rakers lanceolate, dentate, stoutish, wide set, much shorter than eye, the longest two and one half times as long as broad at base, five and one half in the maxillary, about 2+10 in number; pectoral fin about as long as maxillary, which extends beyond the eye, and is rather more than half length of head; dorsal low, its anterior rays somewhat exserted, but short; caudal double concave, the middle rays produced; anal spine obsolete; ventrals small; fins all scaly. D. 88 (85 to 93); A. 66 (65 to 73); Lat. l. about 100.

Blackish olive, mottled and blotched with darker; in life light brown; adults with numerous small white spots on body and vertical fins; sometimes a series of larger white spots along bases of dorsal and anal; about 14 ocellated dark spots on sides, these sometimes inconspicuous, but always present; a series of four or five along dorsal base, and three or four along anal base, those of the two series opposite, and forming pairs; two pairs of smaller, less distinct spots midway between these basal series and lateral line anteriorly, with a small one on lateral line in the center between them; a large distinct spot on lateral line behind middle of straight portion; fins without the round dark blotches.

Is styled flounder, or summer flounder, turbot flounder, toothed flatfish, fluke, and, in Great South bay, it shares the name flatfish with the Pseudopleuronectes americanus. Brail and puckermouth are names applied to it in Rhode Island. The name fluke is the one most frequently used on Long Island.

The fluke is a very abundant fish and is found on the eastern coast from about Cape Cod to the Gulf of Mexico. Centers of abundance are found on the Connecticut coast and on Long Island.

It is a summer visitor in Gravesend bay, arriving in May or June, and leaving when cold weather begins. It frequents the sandy flats for the purpose of feeding on little fishes, which it destroys in large numbers. A fluke will often be found with eight or 10 little blackfish in its stomach, and young mackerel suffer greatly from its depredations. In Great South bay this fish was found at Blue Point cove and at Fire Island late in September, and was caught in traps at Islip October 1, 1890.

Small fluke were collected in Mecox bay, Blue Point cove and at Islip in August 1898. Adults were obtained at Fire Island inlet Sep. 16 of that year, when they were abundant. In 1901 the fish were taken at Fire Island inlet, Blue Point, and Smith's point. Aug. 1 they were feeding on small menhaden. The next day they were seen in Wigo inlet, and again chasing young menhaden. On that date more than half a barrel were caught in the inlet near buoy no. 2, with young menhaden for bait. One of the fluke disgorged a sand lance.

It feeds on small fishes, crustaceans, mollusks and occasionally on sand dollars, and one of its favorite foods is said to be the squid. This fish is found generally in salt water, but frequently ascends fresh streams. Unlike the flatfish, it moves off into deep water in winter, and may be found in summer near the shores. The fluke has the same habit as the flatfish, of burying itself in the sand when alarmed, or secreting itself from its prey. It is often found feeding about wharves, whose supports furnish it a suitable hiding place from which to dart on

small fishes when they are congregated in schools. I have seen large individuals cautiously wriggling their way upward in the concealment of a wharf pile till within easy reach of a shoal of silversides, when a sudden dart into the midst of the school would result in the capture of a fish, and the flounder would leisurely sink to digest its victim and prepare for another onslaught. It has been known to reach a weight of 26 pounds. Dr Goode has seen individuals measuring 3 feet in length. The fish is caught largely in weirs and traps. It is probable that more of them are taken in Vineyard sound and in Rhode Island waters than on any other parts of our coast. The fishing season extends from May to October. They are carried alive in well-smacks to the markets. Menhaden is the bait principally used for the capture of the fluke by hook and line.

361 Paralichthys lethostigmus Jordan & Gilbert

Southern Flounder

Platessa oblonga De Kay, N.Y. Fauna, Fishes, 299, pl. 48, fig. 156, 1842. New York, not *Pleuronectes oblongus* Mitchill.

Paralichthys dentatus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 822, 1883.

Paralichthys lethostigma Jordan & Gilbert, Proc. U. S. Nat. Mus. 237, 1884.

Paralichthys lethostigmus Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2630, 1898.

Body ovate, its depth contained two and one third times in its total length without the caudal; length of head about three and one half times in same length; depth of caudal peduncle contained two and one third times in length of head; eyes of moderate size, placed close together on the left side of the head; mouth large, jaws curved; maxilla reaching past vertical through eye; mandible projecting; anterior teeth of jaws strong; posterior small and close set; gill rakers 2-10, lanceolate, wide set, shorter than eye; scales smooth, small; dorsal originates in front of eye and continues almost to caudal; anal well separated from the ventrals; pectorals short, less than one half length of head; ventral moderately developed, about two thirds length of pectoral. D. 90; A. 70; V. 6.

Color dusky olive, with a few darker mottlings and spots.

This is the fish which was described by Jordan and Gilbert under the name of the southern flounder. It inhabits the south Atlantic and Gulf coast of the United States, ranging north to New York. De Kay described and figured it as the oblong flounder, which he says grows to the length of 15 to 20 inches and occasionally larger. He states that it is common along the sandy shores of New York, and is procured abundantly in the months of September and October; that it is excellent eating, and usually sells at from 6c to 8c a pound; that it is tenacious of life and can be preserved in good condition for a long period.

The southern flounder is very closely related to the fluke or summer flounder. It is, however, always darker in color and almost uniform, while the fluke is usually profusely spotted. The character by which it is best distinguished from the fluke, is the number of gill rakers. The southern flounder has only 12, of which 10 are below the angle of the first arch, while the summer flounder has from 20 to 24, of which from 15 to 18 are below the angle of the first arch.

362 **Paralichthys oblongus** (Mitchill)

Fourspotted Flounder

Pleuronectes oblongus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 391, 1815.
Platessa quadrocellata Storer, Hist. Fish. Mass. 203, pl. XXXI, fig. 3, 1867.
Pseudorhombus oblongus Goode & Bean, Bull. Essex Inst. XI, 7, 1879.
Paralichthys oblongus Goode, Proc. U. S. Nat. Mus. 472, 1880; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 824, 1883; Goode & Bean, Oceanic Ichth. 436, 1896; H. M. Smith, Bull. U. S. F. C. 1897, 108, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2632, 1898; IV, pl. CCCLXXIV, fig. 924, 1900.

Body comparatively elongate, strongly compressed. The depth of the body is contained two and one fourth times in the length of the body, which is four times the length of the head. Eyes large, nearly four times in head, separated by a prominent narrow, sharp ridge; upper jaw with very numerous small, close set teeth laterally, and four or five canines in front, the lateral teeth abruptly smaller than the anterior, each side of lower jaw with seven to 10 teeth; chin prominent, maxillary narrow, reaching past middle of pupil, two and one fourth in length of

head; gape curved; scales weakly ctenoid or cycloid; gill rakers thick, rather long, few, about eight below angle; dorsal low, beginning over front of eye, some of the anterior rays exserted, but not elongate, the longest rays behind middle of fin, not quite half head; caudal one and one fourth in head; pectoral one and three fifths; anal spine obsolete. D. 72; A. 60; Lat. l. 93. (D. 79; A. 59, according to Mitchill; D. 86; A. 76, according to Storer).

Grayish, thickly mottled with darker and somewhat translucent; four large, horizontal oblong, black ocelli, each surrounded by a pinkish area, one just behind middle of body below the dorsal, one opposite this above anal; two similar smaller spots below last rays of dorsal and above last of anal. Atlantic coast, northward; not abundant.

The fourspotted flounder inhabits the coast of New England and New York. It is very common on the coast of New York and the neighboring islands. Mitchill described the fish in 1815. It grows to the length of about 14 inches. Its common name relates to the four large horizontal oblong black ocelli. At Woods Hole Mass., according to Dr Smith, it is common in May and June, scarce at other times. It is most abundant about June, during the run of scup.

Young fish are rarely observed, but in the fall of 1885 and 1886 large numbers, two or three inches long, were seen. The average length of adults there is 12 inches. The fish spawns in May, and its eggs have been experimentally hatched at Woods Hole. They are buoyant, $\frac{1}{16}$ of an inch in diameter and hatch in eight days in water having a mean temperature of 51° to 56° F. In 1877 a single example was taken at the mouth of Salem harbor by the U. S. Fish Commission.

Genus LOPHOPSETTA Gill

Eyes and color on the left side; body broadly ovate, strongly compressed, pellucid; mouth large, oblique, the maxillary reaching to beyond eye; teeth subequal, in narrow bands, or in single series; a small patch of teeth on the vomer; scales small, cycloid, imbricate, the skin without bony tubercles; lateral line strongly arched in front, without accessory branch; dorsal fin beginning

on the snout, its anterior rays exserted; no preanal spine; ventral of left side free from the anal, inserted nearly on the ridge of the abdomen, its base broad, the rays well separated; pectoral and ventral fins moderate. One species. Very close to the European genus Bothus Rafinesque, from which it differs in the more numerous gill rakers, pellucid body and produced dorsal rays. The European turbot, Psetta Swainson, is also closely related, but the typical species, Psetta maxima, is a large, robust fish, scaleless and beset with bony tubercles.

363 **Lophopsetta maculata** (Mitchill)

Window Pane

Pleuronectes maculatus Mitchill, Rep. Fish. N. Y. 9, 1814, New York; De Kay, N. Y. Fauna, Fishes, 301, pl. 47, fig. 151, 1842; Storer, Hist. Fish. Mass. 204, pl. XXXI, fig. 4, 1867.

Pleuronectes aquosus Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 389, pl. II, fig. 3, 1815, New York.

Rhombus aquosus Günther, Cat. Fish. Brit. Mus. IV, 411, 1862.

Bothus maculatus Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 815, 1883; Bean, Bull. Am. Mus. Nat. Hist. IX, 372, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 108, 1898; Bean, 52d Ann. Rep. N. Y. State Mus. 110, 1900.

Lophopsetta maculata Gill, Proc. Ac. Nat. Sci. Phila. 216, 1862; Goode & Bean, Bull. Essex Inst. XI, 6, 1879; Bean, 19th Rep. Comm. Fish. N. Y. 247, 1890; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2660, 1898; IV, pl. CCCLXXXII, fig. 938, 1900.

The length of the body is one and three fifths times the depth of the body and three and three fourths times the length of the head. Body broadly rhomboid, very strongly compressed; interorbital area flattish; eye rather large, about equal to snout; teeth in both jaws in one series laterally, in a very narrow band in front; maxillary nearly half length of head; gill rakers rather long and slender, numerous, about 25 below the angle of the arch; scales well developed, cycloid, loosely imbricated; those of the blind side a little smaller; no bony tubercles; vertical fins scaly; anterior rays of dorsal elevated, branched, with free tips. D. 65; A. 52; Lat. l. 85.

Light olive brown, almost translucent, everywhere marbled with paler, and with many roundish, irregular, blackish blotches; fins spotted. Length 18 inches. Atlantic coast of the United States, very common northward. Size rather small.

This is the plaice according to Mitchill; it is known also as the watery flounder. De Kay calls it the spotted turbot and sand flounder. In Great Egg Harbor bay it is the window light. Windowpane and daylight are other names applied to the species. De Kay saw specimens 18 inches long. He says it is a delicate article of food.

The windowpane is found on the east coast from Maine to North Carolina. Though abundant and well flavored and sometimes reaching a length of a foot or more, it is not an important food fish. In Gravesend bay the fish delights in cold water. It is not adapted to captive life. In Great South bay we took it at Fire Island beach at the end of September 1890. In 1898 an individual was taken at Islip August 18. Young examples were obtained at Fire Island inlet and Oak Island beach in September. In 1901 young individuals were obtained July 31 and Aug. 15 in Fire Island inlet. At Woods Hole Mass. according to Dr Smith, it is found from April to late in the autumn. There is quite a large run about June 1, when the fish is full of spawn. The average size there is 10 to 12 inches. In experimental hatching of the eggs at Woods Hole, it was found that the eggs were buoyant, nonadhesive, $\frac{1}{16}$ of an inch in diameter, and that they hatch in eight days when the average water temperature is 51° to 56° F.

Genus ETROPUS Jordan & Gilbert

Eyes and color on left side; body regularly oval, deep and compressed; head small; mouth very small, the teeth close set, slender, and pointed, somewhat incurved, mostly on the blind side, no teeth on vomer; eyes small, separated by a narrow, scaleless ridge; margin of preopercle free; ventrals free from anal, that of colored side inserted on ridge of abdomen, its base rather long; dorsal fin beginning above eye; caudal double truncate; anal without spine; scales thin, deciduous, ctenoid on left side, cycloid on blind side; lateral line simple, nearly straight. Size small. This genus is very close to Citharichthys, from which it differs only in the very small size of the mouth and in the correspondingly weak dentition. The three

or four known species are similar in appearance to the species of Citharichthys, and they inhabit the same waters. The larval form is translucent and symmetric, as in Platophrys, Monolene, and Arnoglossus.

364 Etropus microstomus (Gill)

Smallmouthed Flounder

Citharichthys microstomus Gill, Proc. Ac. Nat. Sci. Phila, 223, 1864, Beesley's Point N. J.; Bean, Bull. U. S. F. C. VII, 135, 1888, Great Egg Harbor Bay N. J.; Jordan, Proc. U. S. Nat. Mus. 332, 1890; Goode & Bean, Oceanic Ichth. 446, 1896.

Etropus microstomus Jordan & Goss, Rep. U. S. F. C. for 1886, 278, 1889; Bean, 19th Rep. Comm. Fish. N. Y. 247, 1890.

Body ovate. The depth of the body is contained two and one tenth times in its length, which is three and one half times the length of the head. Mouth small, very oblique, the gape curved; maxillary two and two thirds times in length of head, reaching beyond middle of orbit; snout projecting; eyes small, even, shorter than snout, about six in head, separated by a narrow ridge, which is concave and scaleless anteriorly; teeth all small, front teeth of upper jaw wide set, much larger than posterior, which are close together and very small, teeth of lower jaw few, wide apart; gill rakers short and strong, 13 below angle; pectorals short, less than half length of head; scales large, those on middle of sides posteriorly largest. D. 80; A. 61; Lat. l. 45. Individuals from Great Egg Harbor bay have: D. 74; A. 55; scales 41 to 42.

Olive brownish, usually with large blotches of darker; a series of distinct, obscure, blackish blotches along the basal portions of the anal and dorsal fins. Size small. Tropical America, north to Long Island occasionally in summer.

The smallmouthed flounder was first described many years ago by Dr Gill, from a specimen obtained on the New Jersey coast. The fish was not seen again till we collected it in Great South bay, where it was found in moderate numbers at Fire Island, and near Blue Point cove Lifesaving station in September 1884. Since that time it has been found sufficiently common in various parts of Great Egg Harbor bay, N. J., during August

and September, and has also been taken in Great South bay. The individuals collected in Great Egg Harbor bay, varied from 2 inches to 4½ inches in length. One of these was dextral and all the rest sinistral as usual.

Genus LIMANDA Gottsche

Teeth chiefly uniserial; lateral line with a distinct arch in front and without accessory dorsal branch; scales imbricated, rough ctenoid; vertebrae about 40. This genus is closely allied to Pseudopleuronectes, from which it differs only in the presence of an arch on the anterior part of the lateral line.

365 Limanda ferruginea (Storer)

Sand Dab

Platessa ferruginea STORER, Rep. Fish. Mass. 141, pl. 2, 1839; Hist. Fish. Mass. 198, pl. XXX, fig. 4, 1867; DE KAY, N. Y. Fauna, Fishes, 297, pl. 48, fig. 155, 1842.

Platessa rostrata H. R. STORER, Bost. Jour. Nat. Hist. V, I, 268, pl. VIII, fig. 2, 1857.

Pleuronectes ferrugineus GÜNTHER, Cat. Fish. Brit. Mus. IV, 447, 1862; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 834, 1883.

Limanda ferruginea GOODE & BEAN, Bull. Essex Inst. XI, 6, 1879; Oceanic Ichth. 427, 1896; GOODE, Fish & Fish. Ind. U. S. I, pl. 49, 1884; H. M. SMITH, Bull. U. S. F. C. 1897, 108, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2644, 1898; IV, pl. CCCLXXVII, fig. 929, 1900.

The length of the body is two and one fifth times its depth and four times the length of the head. Body ovate-elliptic, strongly compressed; teeth small, conic, close set, in a single series on each side in each jaw; snout projecting, forming a strong angle above upper eye with the descending profile; gill rakers of moderate length, very weak, not toothed; eye moderate, four and one half in head, the lower slightly in advance of the upper, separated by a high, very narrow ridge, which is scaled posteriorly and is continued backward as an inconspicuous but rough ridge to the beginning of the lateral line; scales imbricate, nearly uniform, those on right side rough ctenoid, those on left side nearly or quite smooth, scales on body rougher than on cheeks; caudal peduncle short, higher than long; dorsal inserted over middle of eye, its middle ray highest; pectoral less than two fifths length of head; caudal fin rounded; anal spine present; lateral line simple, with a rather low arch in front, the depth of which is

barely two fifths the length; a concealed spine behind ventrals; ventral of colored side partly lateral, the other wholly so; anal spine strong. D. 85; A. 62; Lat. l. 100.

Brownish olive, with numerous, irregular reddish spots; fins similarly marked; left side with caudal fin, caudal peduncle, and margins of dorsal and anal fins lemon yellow. Atlantic coast, chiefly northward.

This is also known as the rusty dab. It inhabits the coast of North America from Labrador to New York. De Kay calls it the rusty flatfish, which he says is a rare species, reported by the fishermen to occur only in deep water. The specimen described by him was 18 inches long. According to Dr Smith, it is very common in Vineyard sound and observed by him in water from 10 to 12 fathoms deep, where it may be found throughout the year. There is no fishery, but numbers are caught incidently while bottom fishing for other species. In Great harbor a few are taken in fyke nets, only in winter. The average length there is about 14 inches. In Massachusetts bay it is a common resident species, inhabiting deep waters in summer, and approaching the shores in winter.

Genus PSEUDOPLEURONECTES Bleeker

Body oblong, with firm flesh; the scales firm, regularly imbricated, strongly ctenoid on eyed side in both sexes; fin rays scaly; mouth small; teeth uniserial, incisorlike, close set, all more or less blunt, lower pharyngeals very narrow, each with two rows of separate, conic teeth. This genus is distinguished from Pleuronectes chiefly by the well imbricated ctenoid scales, and from Limanda, which it more closely resembles, by the want of arch to the lateral line.

366 Pseudopleuronectes americanus (Walbaum)

Flatfish; Winter Flounder

Pleuronectes americanus WALBAUM, Art. Gen. Pisc. III, 113, 1792; GÜNTHER, Cat. Fish. Brit. Mus. IV, 443, 1862; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 837, 1883.

Pleuronectes planus MITCHILL. Trans. Lit. & Phil. Soc. N. Y. I, 387, 1815, New York.

Platessa plana STORER, Rep. Fish. Mass. 140, 1839; DE KAY, N. Y. Fauna, Fishes, 295, pl. 48, fig. 154, 1842; STORER, Hist. Fish. Mass. 195, pl. XXX, fig. 2, 1867.

Platessa pusilla De Kay, op. cit. 296, pl. 47, fig. 153, 1842, New York.
Pseudopleuronectes americanus Gill, Proc. Ac. Nat. Sci. Phila. 216, 1864; Goode, Fish & Fish. Ind. U. S. I. 182, pl. 44, 1884; Bean, 19th Rep. Comm. Fish. N. Y. 245, pl. I, fig. 1, 1890; Bull. Am. Mus. Nat. Hist. IX, 373, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 108, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2647, 1898; IV, pl. CCCLXXIX, fig. 933, 1900; Bean, 52d Ann. Rep. N. Y. State Mus. 110, 1900; Sherwood & Edwards, Bull. U. S. F. C. 1901, 31, 1901.

Body elliptic, an angle above eye. The length of the body is two and one fourth times its depth and four times the length of the head. Head covered above with imbricated, strongly ctenoid scales similar to those on body; blind side of head nearly naked; interorbital space rather broad, strongly convex, its width half eye; the space entirely scaled; teeth compressed, incisorlike, and widened toward tips, close set, forming a continuous cutting edge, some of teeth often emarginate, sometimes movable; right side of both jaws toothless; highest dorsal rays less than length of pectorals, and more than half length of head; anal spine present. D. 65; A. 48; Lat. l. 83.

Dark rusty brown, spotted or nearly plain; young olive brown, more or less spotted and blotched with reddish.

The common flatfish is equally well known as flounder or winter flounder. It ranges from the Chesapeake bay to Labrador and appears to be alike abundant in both limits of its distribution. The flatfish was found in Blue Point cove, at Blue Point Lifesaving station, and on Fire Island beach. It was moderately common in all of these localities. The species is a permanent resident of Great South bay, but undergoes a partial hibernation in the mud in winter, and the adults in summer migrate into deeper and cooler water. A few individuals were observed by me in a fish pound at Islip Oct. 1, 1890.

Dr Mitchill describes two color varieties of the flatfish. One of these had a yellow margin on the lower side, surrounding the white of that side. This border was three fourths of an inch wide and in striking contrast with the pearl of the contiguous parts within it and the brown of the adjacent fins. The other variety, obtained Ap. 9, 1815, has "a whiteness of the upper side nearly as clear as that of the nether surface over rather more

than half its extent. The anterior part is blanched in this manner. The dorsal fin very sensibly partakes of the lighter hue; but its dark brown is tinctured with yellow, specially on the rays. Something of the same kind, though less distinct, is observable on the ventral fins, and on about a dozen rays of the anal. The length of this individual was 5 inches and the breadth 3. Dr De Kay obtained a specimen in April which was reversed and double. "Its color on both sides was uniform bronze, with a white patch on its right side near the chin, almost entirely denuded of scales; it had the singular protuberance over the eye, noticed by Dr Mitchill in his *melanogaster*."

On the New Jersey coast young individuals are very common in summer, but the adults are rarely found except in the winter.

At Woods Hole Mass. this is a very abundant permanent resident, frequenting muddy or grassy bottoms. The average weight of those taken in the immediate vicinity of the Fish Commission station was only 1 pound, but larger fish are found in the deeper water of the sound and bay. In October fish averaging 2 pounds and apparently migrating are taken with lines in Vineyard sound on sandy bottom.

In the markets this species is extremely common in the winter and spring months and the flesh is delicious even when the eggs are nearly mature. It feeds on small shells, crabs and other invertebrates living in the mud. When at rest it partly submerges itself in the sand or mud, and changes its color to suit its surroundings.

In Long Island bays the flatfish spawns from February to the end of March, and in July the young have attained to the length of half an inch. At Woods Hole Mass. according to Dr Smith, it spawns from February to April. On being transferred to tanks containing running water, many deposit their eggs during the night. The eggs are $\frac{1}{30}$ of an inch in diameter and very glutinous, sticking together in masses of various sizes. The average number to a fish is 500,000. Mar. 6, 1897, a fish that weighed $3\frac{1}{2}$ pounds after spawning furnished 30 fluid ounces of eggs, numbering 1,462,000. The eggs hatch in 17 or 18 days, when the mean water temperature is 37° or 38° F.

Genus PLATOPHRYS Swainson

Eyes and color on the left side; body ovate, strongly compressed; mouth of the large type, but comparatively small; the maxillary one third or less of the length of the head; teeth small, subequal, in one or two series, no teeth on vomer or palatines; interorbital space broad and concave, broadest in adult males; gill rakers moderate; dorsal fin beginning in front of eye, all its rays simple; ventral of colored side on ridge of abdomen; caudal convex behind; pectoral of left side usually with one or more filamentous rays, longest in the male; scales very small, ctenoid, adherent; lateral line with a strong arch in front; coloration usually variegated.

All the species are extremely closely related and can be distinguished with difficulty. On the other hand, the variations due to differences of age and sex are greater than in any other of our genera.

367 Platophrys ocellatus (Agassiz)

Sand Flounder

Rhombus ocellatus AGASSIZ, Spix, Pisc. Brasil. 85. pl. 46, 1829, Brazil.

Platophrys nebularis JORDAN & GILBERT, Proc. U. S. Nat. Mus. 31, 143, 1884, Key West; GOODE & BEAN, Oceanic Ichth. 441, 1896.

Rhomboidichthys ocellatus GÜNTHER, Cat. Fish. Brit. Mus. IV, 433, 1862; POEY, Syn. Pisc. Cubens. 408, 1868.

Platophrys ocellatus SWAINSON, Nat. Hist. Class'n Fishes, II, 302, 1839; BEAN, 19th Rep. Comm. Fish. N. Y. 247, 1890; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2663, 1898; IV, pl. CCCLXXXII, fig. 939, 1900.

Body rhomboid ovate, its depth one half of the total length; length of head one fourth of total without caudal; mouth small, oblique; eyes large, the diameter of the upper eye contained two and two thirds times in length of head, almost equal to depth of caudal peduncle; teeth conic, the upper jaw with two series, the lower with one; the dorsal fin originates a short distance from tip of upper jaw and continues to caudal; ventral origin on a vertical through front of eye; the ventral and anal separated by a short space; pectoral of eyed side about equal in length to caudal; scales of moderate size, those of colored side

ctenoid, of blind side smooth; lateral line sharply arched over two thirds of pectoral. D. 85; A. 64; V. 6 (5 on blind side).

Color light gray with reddish tinge; spots and blotches of darker on head and body; also lighter rings inclosing spaces of ground color; dorsal and anal with a black spot on each sixth or eighth ray.

The sand flounder, or spotted flounder, is a native of the western Atlantic, from New York southward to the Gulf of Mexico and the West Indies, and perhaps to Rio Janeiro on sandy shores. It is a small species, the largest individual taken being only 3 inches in length. Two small examples of this little flounder were collected at Fire Island inlet beach Sep. 30, 1890. These specimens were obtained on a sand beach in shallow water. The discovery of this fish in Great South bay was entirely unexpected, as this is many degrees north of its original habitat.

Family SOLEIDAE

Soles

Genus ACHIRUS Lacépède

Eyes and color on the right side; body oblong, bluntly rounded anteriorly; head small; eyes small, close together, the upper eye in advance of the lower, the two separated by a bony ridge; mouth small, somewhat turned toward the colored side; nasal flaps present, the nostril of the blind side fringed; lip of the colored side fringed; teeth very small, on blind side only; gill openings rather narrow, but confluent below, not reduced to a slit; the branchiostegal region scaled; head closely scaled everywhere, the scales on the colored side similar to those on the body, those of the nape and chin much enlarged; scales on the blind side anteriorly with their pectinations more or less produced, forming cirri, scales of both sides extremely rough, extending on the fins; lateral line straight, simple; edge of preopercle covered by the scales; dorsal beginning on the snout, low in front and thickly scaled, its rays divided; anal fin similar, without spine; caudal fin free, convex; caudal peduncle very

short and deep; pectoral fin of left side wanting, that of right side small or obsolete; ventral rays three or four, the ventral fin of the colored side long, connected with the anal by a membrane. This strongly marked genus contains numerous species, all very closely related, and nearly all American.

368 Achirus fasciatus Lacépède

American Sole; Hogchoker

Achirus fasciatus Lacépède, Hist. Nat. Poiss. IV, 659, 662, 1803. Charleston; Jordan & Goss, Rep. U. S. F. C. 1886, 315, 1889; Bean, Bull. Am. Mus. Nat. Hist. IX, 373, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 108, 1898; Eugene Smith, Proc. Linn. Soc. N. Y. 1897, 41, 1898; Mearns, Bull. Am. Mus. Nat. Hist. X, 322, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2700, 1898; IV, pl. CCCLXXXVII, fig. 948, 1900; Bean, 52d Ann. Rep. N. Y. State Mus. 110, 1900.

Pleuronectes mollis Mitchill, Rep. Fish. N. Y. 9, 1814; Trans. Lit. & Phil. Soc. N. Y. I, 388, pl. II, fig. 4, 1815.

Achirus mollis De Kay, N. Y. Fauna, Fishes, 303, pl. 49, fig. 159, 1842; Storer, Hist. Fish. Mass. 206, pl. XXXII, fig. 1, 1867; Bean, Bull. U. S. F. C. VII, 134, 1888; 19th Rep. Comm. Fish. N. Y. 244, 1890.

Achirus lineatus Cuvier, Règne Anim. ed. 2, II, 343, 1829, and of various American authors.

Form a well rounded oval, regular in outline; head small, its length about one fourth of standard body length; the depth of the body equals one half of the total length; eyes minute, close together on right side of head; mouth small, curved; lateral line distinct, straight; dorsal fin continuous from snout to caudal; ventral connected by membrane with anal, the latter then continuous to caudal; caudal peduncle broad, the fin thumb-shaped; body everywhere densely scaled; anterior dorsal rays scaled; about 75 rows of scales along lateral line. D. 55; A. 40; V. 4.

General color olive brown; body and fins with numerous black spots and clouded areas; usually from six to eight vertical narrow cross bands of black; left side whitish, usually much mottled with dark spots and shadings.

This is called hogchoker, cover clip, or cover, calico and American sole, the name calico is used on the New Jersey shore opposite New York. The American sole has a wide distribution along our east coast, but is not important for food, and sometimes proves very inconvenient to pigs, as may be inferred from one

of its common names. Dr De Kay has eaten the species, however, and pronounces it to have a delicate flavor. Dr Mitchill also describes it as "delicate eating." De Kay records it as high up the Hudson as Peekskill. The following interesting observations are to be found in his work: "When it is taken from the water, it escapes readily from the hand by an undulating movement, in which it is aided by its mucous surface and by an elevation of its scales beneath. By the same means it can make considerable progress over a moderately smooth surface. It is extremely tenacious of life, and I kept one alive four days out of water." Another very curious habit of the American sole is that of clinging to the glass front or side of an aquarium for an indefinite length of time. It is common on the shallow flats of Great South bay in the summer and early fall. We obtained specimens at the mouth of Swan creek and in Blue Point cove in September 1890. This species is abundant in Swan creek, at Patchogue L. I., and many very young examples were taken there in the summer and fall of 1898, where the water was brackish and, at low tide, fresh. In 1901 this species was taken at Howell's point, Duncan's creek and Smith's point.

Eugene Smith caught one very small example in a tidal creek of the Hackensack river, where the water was fresh. He states that it is believed that soles spawn in fresh water.

The American sole, or calico flounder, has been obtained in Gravesend bay every month of the year except the first four. It is hardy in captivity. Its habit of clinging to the glass front and the walls of its tank is interesting.

Order PEDICULATI

Pediculate Fishes

Family LOPHIIDAE

Fishing Frogs

Genus LOPHIUS (Artedi) Linnaeus

Head wide, depressed, very large; body contracted, conic, tapering rapidly backward from the shoulders; mouth exceedingly large, terminal, opening into an enormous stomach; upper jaw protractile, maxillary without supplementary bone; lower

jaw projecting; both jaws with very strong, unequal, cardiform teeth, some of the teeth caninelike, most of them depressible; vomer and palatines usually with strong teeth; gill openings comparatively large, in the lower axil of the pectorals; pseudobranchiae present; no gill rakers; gills three; skin mostly smooth, naked, with many dermal flaps about the head; spinous dorsal of three isolated, tentaclelike spines on the head, and three smaller ones behind, which form a continuous fin; second dorsal moderate, similar to the anal; pectoral members scarcely geniculated, each with two actinosts and with elongate pseudobrachia; ventrals jugular, I, 5, widely separated, large, much enlarged in the young. Young with the head spinous. Pyloric caeca present. Vertebrae numerous, about 30 in number. Living on sea bottoms, at moderate depths; remarkable for great voracity.

369 Lophius piscatorius Linnaeus

Angler; Goosefish; Bellows Fish

Lophius piscatorius Linnaeus, Syst. Nat. ed. X, I. 236, 1758; Mitchill, Trans. Lit. & Phil. Soc. N. Y. I, 465, 1815; Günther, Cat. Fish. Brit. Mus. III, 179, 1861; Goode & Bean, Bull. Essex Inst. XI, 2, 1879; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 844, 1883; Bean, Bull. Am. Mus. Nat. Hist. IX, 373, 1897; H. M. Smith, Bull. U. S. F. C. 1897, 109, 1898; Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2713, 1898; IV, pl. CCCLXXXVIII, fig. 952 (skeleton), 1900; Sherwood & Edwards, Bull. U. S. F. C. 1901, 31, 1901.

Lophius piscator Mitchill, Rep. Fish. N. Y. 28, 1814, Long Island.

Lophius americanus Cuvier & Valenciennes, Hist. Nat. Poiss. XII, 380, 1837; De Kay, N. Y. Fauna, Fishes, 162, pl. 28, fig. 87, 1842; Storer, Hist. Fish. Mass. 101, pl. XVIII, fig. 2, 1867.

Body depressed, tapering, scarcely longer than head; humeral spine with points, of which the posterior is the longest; head surrounded with a fringe of barbels; top of head in young with many strong spines; anterior dorsal spine elongate, fleshy at tip. D. I–I–I, III–10; A. 9.

Brownish, mottled, below white; mouth from behind the hyoid bone immaculate; pectorals and caudal black at tip; peritoneum black. North Atlantic, on both coasts; generally common, from North Carolina northward. A fish of singular ugliness of appearance.

De Kay calls this fish the American angler. He says it is not an uncommon fish in New York waters, and that among its popular names are sea devil, fishing frog, bellows fish, goosefish, monkfish, and various others. The largest one he saw was 4 feet long. It is not eaten, but is often opened by fishermen for the numerous fishes which are found in its stomach. He says it is found on the south side of Long Island.

The angler is moderately abundant on the fishing banks in the vicinity of New York city, and small ones are sometimes caught in Gravesend bay. No examples of this fish were obtained by me in Great South bay during three seasons of summer investigations, but it is found sparingly in the ocean adjacent to the bay.

According to Dr Smith, it is abundant in Vineyard sound, usually from Ap. 1 to July 1, some seasons from April to November, or as late as the traps are set. Traps often take boat loads of these fish, which are carried to the shore and put on the land. No other use is made of them, though the flesh is considered very palatable. Those caught in traps are from 4 inches to 4 feet long. The young keep off shore in deep water and are never taken in the seine. The spawn is often found floating in Vineyard sound. During the fall of 1900, according to Sherwood and Edwards, anglers were very abundant in Great harbor, at Woods Hole Mass. and late in the fall several large ones were washed ashore. The fish are not often seen near Woods Hole, though abundant at Menemsha and Cuttyhunk, where the shores are frequently strewn with their bleached skeletons.

In Massachusetts bay it is a common resident of the deep waters, often coming to the shores. An individual about 4 inches in length was taken off the banks of Newfoundland in 1856. This is probably the most northern recorded occurrence of the fish in the western Atlantic, except the unconfirmed statement by Pennant of its appearance in Hudson's bay. The angler ranges from North Carolina northward. Mitchill called this fish the sea devil.

Family ANTENNARIIDAE

Genus PTEROPHRYNE Gill

Body smooth or scarcely granular, short, somewhat compressed, with tumid abdomen; mouth small, oblique; palate with

teeth; wrist and pectoral fin slender; ventrals elongated; soft dorsal and anal vertically expanded. Small fishes of fantastic shape in the West Indies and Gulf Stream.

370 Pterophryne histrio (Linnaeus)

Mousefish

Lophius histrio LINNAEUS, Syst. Nat. ed. X, I, 237. 1758.
Chironectes bicaudatus STORER, Rep. Fish. Mass. 73. 1839; DE KAY, N. Y. Fauna, Fishes, 165, pl. 27, fig. 83, 1842.
Antennarius histrio JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus. 846, 1883.
Pterophryne histrio GILL, Proc. U. S. Nat. Mus. 216, 1878; GOODE & BEAN, Oceanic Ichth. 486, 1896; BEAN, Bull. Am. Mus. Nat. Hist. IX, 373, 1897; H. M. SMITH, Bull. U. S. F. C. 1897, 109, 1898; JORDAN & EVERMANN, Bull. 47, U. S. Nat. Mus. III, 2716, 1898.

The length of the body is one and four fifths times its depth and two and one fourth times the length of the head; skin of head and body, as well as dorsal fins, with fleshy tags, which are most numerous on the dorsal spines and abdomen; wrist slender; ventrals large, nearly half as long as head; dorsal and anal with posterior rays not adnate to the caudal peduncle. D. III–11; A. 7; V. 5.

Yellowish, marbled with brown; three dark bands radiating from eye; vertical fins barred with brown; belly and sides with small white spots. Tropical parts of Atlantic; abundant on our Gulf coast and occasional northward.

The mousefish inhabits the tropical parts of the Atlantic. It is abundant on our Gulf coast and occasional northward to Cape Cod, specially in floating masses of Sargassum. It was once taken in Europe in floating seaweed, from the Gulf Stream, and has been recorded from the coast of Senegambia.

De Kay described this species under the name of the smooth mousefish. He refers to the descriptions of Cuvier and Valenciennes, and Storer. He states that the geographic range of the species at that time was known to extend from Charleston to Boston.

This species is not uncommon in summer in floating masses of gulf weed brought near our shores by the Gulf Stream and other currents. An example was caught off the ocean shore of Long

Island in August 1897. At Woods Hole Mass., according to Dr Smith, it was taken in 1877. In November 1885, 12 specimens were seined in Quissett harbor. From that year till 1897 none were observed, but in 1897 the fish were comparatively common in Vineyard sound. During July there was an unusual prevalence of southerly winds, and a large quantity of sargasso weed was blown in from the Gulf Stream, and with it this fish, which he calls the marbled angler. In Vineyard sound, a few miles from Woods Hole, 50 individuals were taken July 24, 1897. Probably not less than 100 specimens were taken during that year. Many were kept alive in aquaria for several weeks. Some remain under or among the gulf weed at the surface, some conceal themselves in the algae on the bottom, some hide behind stones and other objects, and some seek crevices among rocks. While clumsy in their movements, they were adept in approaching and capturing other fishes. They were cannibalistic, one about 6 inches long swallowing another 4 inches long, and they frequently bit off the fleshy dermal appendages of their fellows. In August several spawned in the aquarium. The eggs are connected in long bands, like those of the angler. It is reported that in the summer of 1889 the fish was not uncommon off Nantucket, and in 1897, eight specimens were taken in gulf weed off that island.

Family OGCOCEPHALIDAE

Batfishes

Genus OGCOCEPHALUS Fischer

Body stoutish, tapering backward; head very broad and depressed, triangular in form, the forehead elevated and produced; eyes large, lateral; mouth rather small, subinferior under the snout; villiform teeth in bands on jaws, vomer and palatines; skin covered with rough, bony tubercles; dorsal and anal fins very small; rostral tentacle present, retractile into a cavity under a bony prominence on the forehead; ventrals present, I, 5, well separated; pectorals large, placed horizontally; gills $2\frac{1}{2}$; no air bladder; no pyloric caeca. Tropical America, in shallow water. Small fishes of singular form, often regarded by the ignorant as venemous.

371 Ogcocephalus vespertilio (Linnaeus)

Batfish; Malthe

Lophius vespertilio Linnaeus, Syst. Nat. ed. X, I, 236, 1758.

Malthaca vespertilio Cuvier & Valenciennes, Hist. Nat. Poiss. XII, 440, 1837; De Kay, N. Y. Fauna, Fishes, 167, 1842.

Malthe vespertilio Gunther, Cat. Fish. Brit. Mus. III, 200, 1861; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus. 850, 1883.

Ogcocephalus vespertilio Jordan & Evermann, Bull. 47, U. S. Nat. Mus. III, 2737, 1898; IV, pl. CCCXCII, figs. 958, 958a, 958b, 1900; Bean, Science, N. S. IX, no. 211, 8, 1899.

Anterior half of body (the head), between eyes and gill openings, much depressed and broadened, the greatest width in front of gill openings equaling distance from tip of rostral process to gill openings or about half length of entire fish; from gill openings to caudal the body is rounded, tapering to the tail; the width of the body at the vent equals one third of the width at gill openings; forehead produced in a subconic process of varying length, its length measured from eye being contained six and one half times or more in total length without caudal; mouth small, inferior; jaws, vomer, and palatines with bands of villiform teeth. D. 4; A. 4; V. I, 5.

Color dark gray and brown, often varying from almost black to light gray and orange.

The batfish is a West Indian species, ranging north to the Florida Keys, and has been taken at least once in the harbor of New York. It grows to a length of 12 inches. De Kay did not meet with this fish on the coast of New York, but he copies the description of Cuvier and Valenciennes. In the midsummer of 1854 or 1855, Dr Theodore Gill saw an individual of this species, which was recently caught at a wharf at the foot of 27th st. East river, New York. No record of its occurrence was published, but the writer noted this circumstance in *Science*, Jan. 13, 1899, n. s. v. 9.

RECORDED DISTRIBUTION OF NEW YORK FISHES

	Great lakes	Interior lakes	St Lawrence	Adirondacks	Lake Champlain	Ohio basin	Susquehanna basin	Delaware basin	Hudson basin	Long Island streams	Marine	Anadromous
1 Petromyzon marinus	---	---	---	---	---	---	---	---	---	---	x	x
2 P. marinus unicolor	---	x	---	---	---	---	---	---	---	---	---	---
3 Ichthyomyzon concolor	x	---	x	---	x	x	---	---	---	---	---	---
4 Lampetra wilderi	x	x	---	---	---	x	---	---	---	---	---	---
5 Pseudotriakis microdon	---	---	---	---	---	---	---	---	---	---	x	---
6 Mustelus canis	---	---	---	---	---	---	---	---	---	---	x	---
7 Galeocerdo tigrinus	---	---	---	---	---	---	---	---	---	---	x	---
8 Prionace glauca	---	---	---	---	---	---	---	---	---	---	x	---
9 Carcharhinus obscurus	---	---	---	---	---	---	---	---	---	---	x	---
10 C. milberti	---	---	---	---	---	---	---	---	---	---	x	---
11 Aprionodon isodon	---	---	---	---	---	---	---	---	---	---	x	---
12 Scoliodon terrae-novae	---	---	---	---	---	---	---	---	---	---	x	---
13 Sphyrna tiburo	---	---	---	---	---	---	---	---	---	---	x	---
14 S. zygaena	---	---	---	---	---	---	---	---	---	---	x	---
15 Alopias vulpes	---	---	---	---	---	---	---	---	---	---	x	---
16 Carcharias littoralis	---	---	---	---	---	---	---	---	---	---	x	---
17 Isurus dekayi	---	---	---	---	---	---	---	---	---	---	x	---
18 Lamna cornubica	---	---	---	---	---	---	---	---	---	---	x	---
19 Carcharodon carcharias	---	---	---	---	---	---	---	---	---	---	x	---
20 Cetorhinus maximus	---	---	---	---	---	---	---	---	---	---	x	---
21 Squalus acanthias	---	---	---	---	---	---	---	---	---	---	x	---
22 Squatina squatina	---	---	---	---	---	---	---	---	---	---	x	---
23 Raja erinacea	---	---	---	---	---	---	---	---	---	---	x	---
24 R. ocellata	---	---	---	---	---	---	---	---	---	---	x	---
25 R. eglanteria	---	---	---	---	---	---	---	---	---	---	x	---
26 R. laevis	---	---	---	---	---	---	---	---	---	---	x	---
27 Tetranarce occidentalis	---	---	---	---	---	---	---	---	---	---	x	---
28 Dasyatis centrura	---	---	---	---	---	---	---	---	---	---	x	---
29 D. hastata	---	---	---	---	---	---	---	---	---	---	x	---
30 D. say	---	---	---	---	---	---	---	---	---	---	x	---
31 Pteroplatea maclura	---	---	---	---	---	---	---	---	---	---	x	---
32 Myliobatis freminvillei	---	---	---	---	---	---	---	---	---	---	x	---
33 Rhinoptera bonasus	---	---	---	---	---	---	---	---	---	---	x	---
34 Polyodon spathula	x	---	---	---	---	x	---	---	---	---	---	---
35 Acipenser sturio	---	---	x	---	---	---	---	---	---	---	x	x
36 A. rubicundus	x	---	x	---	x	---	---	---	---	---	---	---
37 A. brevirostris	---	---	x	---	---	---	---	---	---	---	x	x
38 Lepisosteus osseus	x	---	x	---	x	x	---	---	---	---	---	---
39 L. platostomus	x	---	---	---	---	x	---	---	---	---	---	---
40 Amia calva	x	x	x	---	x	x	---	---	---	---	---	---
41 Felichthys marinus	---	---	---	---	---	---	---	---	---	---	x	---
42 Galeichthys felis	---	---	---	---	---	---	---	---	---	---	x	---
43 Ictalurus punctatus	x	---	---	---	---	---	---	---	---	---	---	---
44 Ameiurus lacustris	x	---	x	---	x	---	---	---	---	---	---	---
45 A. natalis	x	x	---	---	---	---	---	---	---	---	---	---
46 A. vulgaris	x	x	---	---	x	---	---	---	---	---	---	---
47 A. catus	---	---	---	---	---	---	x	x	x	---	---	---
48 A. nebulosus[1]	x	---	x	---	x	x	x	---	x	x	---	---
49 A. nebulosus marmoratus	---	---	---	---	---	---	---	---	x	---	---	---
50 A. melas	x	---	x	---	---	x	---	---	---	---	---	---
51 Noturus flavus	x	---	---	---	---	---	---	---	---	---	---	---
52 Schilbeodes gyrinus[1]	x	x	---	---	---	---	---	---	---	---	---	---

[1] Recorded also from the Walkill, Passaic and Hackensack.

Recorded distribution of New York fishes *(continued)*

		Great lakes	Interior lakes	St Lawrence	Adirondacks	Lake Champlain	Ohio basin	Susquehanna basin	Delaware basin	Hudson basin	Long Island streams	Marine	Anadromous
53	S. insignis	x					x	x	x				
54	S. miurus	x					x						
55	Carpiodes thompsoni	x		x		x							
56	Catostomus catostomus	x	x	x		x							
57	C. commersonii[1]	x	x	x		x	x	x	x	x			
58	C. nigricans	x					x	x	x				
59	Erimyzon sucetta[2]									x			
60	E. sucetta oblongus	x	x	x				x	x	x			
61	Minytrema melanops	x					x						
62	Moxostoma anisurum	x		x									
63	M. aureolum	x	x	x		x	x			x			
64	Campostoma anomalum	x					x						
65	Chrosomus erythrogaster	x		x				x					
66	Hybognathus nuchalis	x											
67	Pimephales promelas	x					x						
68	P. notatus	x	x	x		x	x						
69	Semotilus bullaris	x		x		x		x	x	x			
70	S. atromaculatus	x		x		x	x	x	x	x			
71	Tinca tinca										x		
72	Leuciscus elongatus	x											
73	L. margarita	x						x					
74	Idus idus										x		
75	Abramis crysoleucas[1]	x	x	x		x		x	x	x			
76	A. crysoleucas roseus, Cen'l Park												
76½	Cliola vigilax	x											
77	Notropis bifrenatus								x				
78	N. anogenus		x										
79	N. cayuga	x	x				x						
80	N. heterodon	x	x										
81	N. blennius	x		x		x							
82	N. procne						x	x	x				
83	N. hudsonius	x		x		x	x		x	x			
84	N. hudsonius amarus	x						x					
85	N. whipplii	x	x	x		x	x						
86	N. cornutus	x		x		x	x	x	x	x			
87	N. cornutus frontalis	x	x										
88	N. atherinoides	x	x	x		x							
89	N. rubifrons	x		x		x	x						
90	N. amoenus									x			
91	N. umbratilis		x										
91½	Ericymba buccata	x											
92	Rhinichthys cataractae	x	x	x		x							
93	R. atronasus[1]	x		x		x	x	x	x	x			
94	Hybopsis dissimilis	x					x						
94½	H. amblops	x											
95	H. storerianus	x											
96	H. kentuckiensis	x	x				x	x		x			
97	Couesius plumbeus			x	x	x							
98	Exoglossum maxillingua	x	x	x		x		x	x	x			
99	Carassius auratus									x	x		
100	Cyprinus carpio	x	x				x			x	x		
101	Anguilla chrysypa[1]	x	x	x		x		x	x	x			

[1] Recorded also from the Walkill, Passaic and Hackensack.
[2] Recorded also from the Passaic and Hackensack.

Recorded distribution of New York fishes *(continued)*

	Great lakes	Interior lakes	St Lawrence	Adirondacks	Lake Champlain	Ohio basin	Susquehanna basin	Delaware basin	Hudson basin	Long Island streams	Marine	Anadromous
102 Leptocephalus conger											X	
103 Tarpon atlanticus											X	
104 Elops saurus											X	
105 Albula vulpes											X	
106 Hiodon tergisus	X		X		X	X						
107 H. alosoides	X					X						
108 Dorosoma cepedianum	X					X						
109 Etrumeus teres											X	
110 Clupea harengus			X								X	
111 Pomolobus chrysochloris	X					X						
112 P. mediocris												X
113 P. pseudoharengus	X	X	X				X	X	X			X
114 P. cyanonoton												X
115 Alosa sapidissima	X		X									X
116 Harengula sp											X	
117 Opisthonema oglinum											X	
118 Brevoortia tyrannus											X	
119 Stolephorus brownii											X	
120 S. argyrophanus											X	
121 S. perfasciatus											X	
122 S. mitchilli											X	
123 Coregonus quadrilateralis	X		X	X	X							
124 C. clupeiformis	X	X	X	X	X							
125 Argyrosomus osmeriformis		X										
126 A. artedi	X	X										
127 A. hoyi		X										
128 A. prognathus	X											
129 A. tullibee		X										
130 Oncorhynchus chouicha	X											
131 Salmo salar	X		X		X				X			
132 S. salar sebago				X	X					X		
133 S. henshawi												
134 S. gairdneri	X											
135 S. fario										X		
136 S. trutta levenensis												
137 S. irideus										X		
138 S. lemanus				X								
139 Cristivomer namaycush	X	X	X	X	X							
140 Salvelinus fontinalis[1]		X	X	X	X	X		X		X		
141 S. alpinus[2]												
142 S. alpinus aureolus[3]												
143 Osmerus mordax											X	X
144 Synodus foetens											X	
145 Umbra limi	X	X	X		X							
146 U. pygmaea[4]									X	X		
147 Lucius americanus								X	X	X		
148 L. vermiculatus	X					X						
149 L. reticulatus[1]	X	X	X		X				X	X		
150 L. lucius	X	X	X		X							
151 L. masquinongy	X		X		X							

[1] Recorded also from the Walkill and Passaic.
[2] Introduced into Sterling lake.
[3] Introduced into Lake George.
[4] Recorded from the Passaic and Hackensack.

Recorded distribution of New York fishes *(continued)*

	Great lakes	Interior lakes	St Lawrence	Adirondacks	Lake Champlain	Ohio basin	Susquehanna basin	Delaware basin	Hudson basin	Long Island streams	Marine	Anadromous
152 L. m. ophiensis (Kirt.)						X						
153 Fundulus majalis											X	
154 F. heteroclitus											X	
155 F. diaphanus[1]	X	X	X						X	X		
156 Lucania parva										X	X	
157 Cyprinodon variegatus											X	
158 Tylosurus marinus											X	
159 T. raphidoma											X	
160 T. acus											X	
161 Hyporhamphus roberti											X	
162 Euleptorhamphus velox											X	
163 Scomberesox saurus											X	
164 Exocoetus volitans											X	
165 Cypsilurus heterurus											X	
166 C. furcatus											X	
167 C. gibbifrons											X	
168 Eucalia inconstans	X		X		X							
169 E. inconstans cayuga		X										
170 Pygosteus pungitius[1]	X										X	X
171 Gasterosteus bispinosus	X							X	X		X	
172 Apeltes quadracus											X	X
173 Fistularia tabaccaria											X	
174 Siphostoma fuscum											X	
175 Hippocampus hudsonius											X	
176 Percopsis guttatus	X		X		X			X				
177 Aphredoderus sayanus	X							X	X ?	X		
178 Menidia gracilis											X	X
179 M. beryllina										X		
180 M. notata											X	
181 Kirtlandia vagrans											X	
182 Labidesthes sicculus	X	X				X						
183 Mugil cephalus												
184 M. curema											X	
185 M. trichodon											X	
186 Syphraena guachancho											X	
187 S. borealis											X	
188 Polydactylus octonemus											X	
189 Ammodytes americanus											X	
190 Mullus auratus											X	
191 Scomber scombrus											X	
192 S. colias											X	
193 Auxis thazard											X	
194 Gymnosarda pelamis											X	
195 G. alleterata											X	
196 Thunnus thynnus											X	
197 Sarda sarda											X	
198 Scomberomorus maculatus											X	
199 S. regalis											X	
200 S. cavalla											X	
201 Trichiurus lepturus											X	
202 Istiophorus nigricans											X	
203 Tetrapturus imperator											X	

Recorded also from the Passaic and Hackensack.

Recorded distribution of New York fishes *(continued)*

	Great lakes	Interior lakes	St Lawrence	Adirondacks	Lake Champlain	Ohio basin	Susquehanna basin	Delaware basin	Hudson basin	Long Island streams	Marine	Anadromous
204 Xiphias gladius											x	
205 Oligoplites saurus											x	
206 Naucrates ductor											x	
207 Seriola zonata											x	
208 S. lalandi											x	
209 Elagatis bipinnulatus											x	
210 Decapterus punctatus											x	
211 D. macarellus											x	
212 Trachurus trachurus											x	
213 Trachurops crumenophthalmus											x	
214 Caranx hippos											x	
215 C. crysos											x	
216 Alectis ciliaris											x	
217 Vomer setipinnis											x	
218 Selene vomer											x	
219 Chloroscombrus chrysurus											x	
220 Trachinotus falcatus											x	
221 T. argenteus											x	
222 T. carolinus											x	
223 Pomatomus saltatrix									x		x	
224 Rachycentron canadum									x		x	
225 Coryphaena hippurus											x	
226 C. equisetis											x	
227 Palinurichthys perciformis											x	
228 Rhombus paru											x	
229 R. triacanthus											x	
230 Pomoxis annularis	x											
231 P. sparoides	x	x										
232 Acantharchus pomotis [1]												
233 Ambloplites rupestris [2]	x	x	x		x	x				x		
234 Chaenobryttus gulosus	x											
235 Enneacanthus obesus [1]												
236 E. gloriosus [3]												
237 Apomotis cyanellus	x	x										
238 Lepomis auritus									x			
239 L. pallidus	x	x				x						
240 Eupomotis gibbosus [4]	x	x	x	x	x	x	x	x	x	x		
241 Micropterus dolomieu [5]	x	x	x	x	x	x	x	x	x	x		
242 M. salmoides [6]	x	x	x	x	x	x	x	x	x	x		
243 Stizostedion vitreum	x	x	x		x	x	x	x				
244 S. canadense	x	x	x		x							
245 S. canadense griseum	x	x										
246 Perca flavescens [7]	x	x	x	x	x	x	x	x	x	x		
247 Percina caprodes			x		x	x						
248 P. caprodes zebra	x		x									
249 Hadropterus aspro	x											
250 Cottogaster copelandi	x				x							
251 C. cheneyi			x									

[1] Recorded in the Hackensack.
[2] Introduced into the Passaic and Long Island waters.
[3] Recorded from Long pond, Hudson Highlands.
[4] Recorded also from the Walkill, Passaic and Hackensack.
[5] Introduced into the Passaic.
[6] Recorded from the Walkill, Passaic and Bronx.
[7] Recorded from the Passaic and Hackensack.

Recorded distribution of New York fishes *(continued)*

		Great lakes	Interior lakes	St Lawrence	Adirondacks	Lake Champlain	Ohio basin	Susquehanna basin	Delaware basin	Hudson basin	Long Island streams	Marine	Anadromous
252	Diplesion blennioides	x											
253	Boleosoma nigrum	x											
254	B. nigrum olmstedi[1]	x	x	x		x					x		
255	Etheostoma coeruleum	x					x						
255½	E. boreale	x		x									
256	E. flabellare[2]	x	x	x			x						
257	Boleichthys fusiformis	x											
258	B. fusiformis eos	x											
259	Roccus chrysops[3]	x					x						
260	R. lineatus			x				x	x	x	x		x
261	Morone americana									x	x		x
262	Polyprion americanus											x	
263	Epinephelus niveatus											x	
264	Centropristes striatus											x	
265	Dules auriga											x	
266	Rypticus bistrispinus											x	
267	Lobotes surinamensis											x	
268	Priacanthus arenatus											x	
269	Pseudopriacanthus altus											x	
270	Neomaenis griseus											x	
271	N. blackfordi											x	
272	Orthopristis chrysopterus											x	
273	Stenotomus chrysops											x	
274	Lagodon rhomboides											x	
275	Archosargus probatocephalus											x	
276	Eucinostomus gula											x	
277	Kyphosus sectatrix											x	
278	Cynoscion regalis											x	
279	C. nebulosus											x	
280	Larimus fasciatus											x	
281	Bairdiella chrysura											x	
282	Sciaenops ocellatus											x	
283	Leiostomus xanthurus											x	
284	Micropogon undulatus											x	
285	Menticirrhus saxatilis											x	
286	Pogonias cromis											x	
287	Aplodinotus grunniens	x				x							
288	Tautogolabrus adspersus											x	
289	Tautoga onitis											x	
290	Zenopsis ocellatus											x	
291	Chaetodipterus faber											x	
292	Chaetodon ocellatus											x	
293	Teuthis hepatus											x	
294	Balistes carolinensis											x	
295	B. vetula											x	
296	Monacanthus hispidus											x	
297	Alutera schoepfii											x	
298	Lactophrys trigonus											x	
299	Lagocephalus laevigatus											x	
300	Spheroides maculatus											x	
301	S. testudineus											x	

[1] Recorded from the Passaic, Hackensack and Bronx.
[2] Recorded from the Hackensack.
Introduced into Greenwood lake.

Recorded distribution of New York fishes *(continued)*

	Great lakes	Interior lakes	St Lawrence	Adirondacks	Lake Champlain	Ohio basin	Susquehanna basin	Delaware basin	Hudson basin	Long Island streams	Marine	Anadromous
302 S. trichocephalus											x	
303 T. trichodiodon pilosus											x	
304 Chilomycterus schoepfii											x	
305 C. fuliginosus											x	
306 Mola mola											x	
307 Sebastes marinus											x	
308 Helicolenus dactylopterus											x	
309 Cottus ictalops	x		x			x						
310 Uranidea gracilis[1]		x	x	x	x							
311 U. formosa						x						
312 Myoxocephalus aeneus											x	
313 M. octodecim-spinosus											x	
314 M. groenlandicus											x	
315 Triglopsis thompsoni	x											
316 Hemitripterus americanus											x	
317 Aspidophoroides monopterygius											x	
318 Cyclopterus lumpus											x	
319 Neoliparis atlanticus											x	
320 Liparis liparis											x	
321 Gobiosoma bosci											x	
322 Astroscopus guttatus											x	
323 Opsanus tau											x	
324 Blennius fucorum											x	
325 Chasmodes bosquianus											x	
326 Pholis gunnellus											x	
327 Ulvaria subbifurcata											x	
328 Stichaeus punctatus											x	
329 Lumpenus lampetraeformis											x	
330 Cryptacanthodes maculatus											x	
331 Anarhichas lupus											x	
332 Zoarces anguillaris											x	
333 Rissola marginata											x	
334 Prionotus carolinus											x	
335 P. strigatus											x	
336 P. tribulus											x	
337 Trigla cuculus											x	
338 Cephalacanthus volitans											x	
339 Echeneis naucrates											x	
340 E. naucrateoides											x	
341 Remora remora											x	
342 R. brachyptera											x	
343 Rhombochirus osteochir											x	
344 Merlucius bilinearis											x	
345 Pollachius virens											x	
346 Microgadus tomcod									x		x	x
347 Gadus morrhua											x	
348 Melanogrammus aeglifinus											x	
349 Lota maculosa	x	x	x		x							
350 Urophycis regius											x	
351 U. tenuis											x	
352 U. chuss											x	
353 Gaidropsarus argentatus											x	
354 G. ensis											x	

[1]Recorded also in the Hackensack and Passaic.

Recorded distribution of New York fishes *(concluded)*

	Great lakes	Interior lakes	St Lawrence	Adirondacks	Lake Champlain	Ohio basin	Susquehanna basin	Delaware basin	Hudson basin	Long Island streams	Marine	Anadromous
355 Rhinonemus cimbrius	...	...	...	...	...	...	...	...	...	...	x	...
356 Brosmius brosme	...	...	...	...	...	...	...	...	...	...	x	...
357 Coelorhynchus carminatus	...	...	...	...	...	...	...	...	...	...	x	...
358 Hippoglossus hippoglossus	...	...	...	...	...	...	...	...	...	...	x	...
359 Hippoglossoides platessoides	...	...	..	...	...	...	...	...	...	...	x	...
360 Paralichthys dentatus	...	...	...	...	...	...	...	...	...	...	x	...
361 P. lethostigma	...	...	...	...	...	...	...	...	...	...	x	...
362 P. oblongus	...	...	...	...	...	...	...	...	...	...	x	...
363 Lophopsetta maculata	...	...	...	...	...	...	...	...	...	...	x	...
364 Etropus microstomus	...	...	...	...	...	...	...	...	...	...	x	...
365 Limanda ferruginea	...	...	...	...	...	...	...	...	...	...	x	...
366 Pseudopleuronectes americanus	...	...	...	...	...	...	...	...	...	...	x	...
367 Platophrys ocellatus	...	...	...	...	...	...	...	...	...	...	x	...
368 Achirus fasciatus[1]	...	...	...	...	...	...	...	...	x	x	x	x
369 Lophius piscatorius	...	...	...	...	...	...	...	...	...	...	x	...
370 Pterophryne histrio	...	...	...	...	...	...	...	...	...	...	x	...
371 Ogcocephalus vespertilio	...	...	...	...	...	...	...	...	...	...	x	...

[1] Recorded also from the Hackensack.

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FREDERICK J. H. MERRILL Director
EPHRAIM PORTER FELT State Entomologist

Bulletin 57

ENTOMOLOGY 15

ELM LEAF BEETLE

IN

NEW YORK STATE

Edition 2

BY

EPHRAIM PORTER FELT D.Sc.

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University of the State of New York

New York State Museum

FREDERICK J. H. MERRILL Director

EPHRAIM PORTER FELT State entomologist

Bulletin 57

ENTOMOLOGY 15

ELM LEAF BEETLE

IN

NEW YORK STATE

PREFACE

This bulletin appeared in June 1898 and as the first edition is practically exhausted, a revision embodying the more essential facts observed since then has been prepared in order to meet the demand for information concerning this deadly enemy of our elms, which is still extending its range in this state. This beetle has abundantly demonstrated its injurious powers in the vicinity of Albany, and in turn the feasibility of controlling it at a very reasonable expense has been proved.

The life history and habits of this beetle have been given somewhat in detail because unless they are thoroughly understood it is very easy to adopt means that are futile or only partially successful. In order to give the bulletin a more practical value, short accounts have also been included of three other insects, which, working with the elm leaf beetle, have aided greatly in ruining many noble elms.

In the portion devoted to remedies prominence has been given to the cost of spraying per tree, the proper apparatus and the time and manner of application. It is surprising to see what mistakes some make in dealing with insects and how methods of no value are clung to. To offset this tendency, two of the more common fallacies are mentioned and their futility shown.

E. P. FELT

Albany N. Y. January 1902

ELM LEAF BEETLE IN NEW YORK STATE

Galerucella luteola Müller

Ord. Coleoptera: Fam. Chrysomelidae

This insect has committed such extensive injuries to elms in cities and villages along the Hudson that it may be regarded as the most important natural enemy of shade trees in this state. Its depredations in this section probably outrank those of all other natural agents combined. Residents of places where this pest has established itself have repeatedly observed the grubs working on their elms and in many instances have seen two, or even three, crops of leaves destroyed in a single season without taking steps for the protection of their trees.

The causes for this condition of affairs are not hard to find, as the majority, if they notice the work of this pest at all, are inclined to trust in Providence and hope that its ravages will not be as severe the next season. Others see the grubs at work on the under side of the leaves or crawling about the tree but not being quite sure of the best method of controlling them, and as any method takes considerable labor, usually make no effort to subdue the pest.

Bad reputation of its family. This beetle is a member of the large, leaf eating family of Chrysomelidae, which comprises a number of our most injurious insects. It includes such well known pests as the asparagus beetle, Crioceris asparagi Linn., the Colorado potato beetle, Doryphora 10-lineata Say, the 12 spotted Diabrotica, D. 12-punctata Oliv. and the striped cucumber beetle, Diabrotica vittata Fabr., all well known insects against which the farmer must wage a more or less perpetual warfare. Another member of this family, the cottonwood leaf beetle, Lina scripta Fabr., recently inflicted serious damage on the large basket industry in the willow growing districts about Syracuse, Rochester and other localities in that part of the state. Judging from the well known records of its allies, we may expect that the elm leaf beetle will continue to be very destructive.

Recent injuries about Albany. The elm leaf beetle was recognized in Albany by the late Dr Lintner about 1892, having

probably made its way here a year or two earlier. Its ravages became more and more serious from that time till 1897, when most of the European elms along our streets were completely defoliated in early summer. The second growth of foliage was seriously injured the same year and some trees had their third set of leaves attacked. It was estimated in 1898 that fully 1000 elms had been killed within the city limits by this pernicious insect and many more would have suffered a similar fate, had it not been for the systematic spraying undertaken then and since continued. See pl. 3 and 4 for representations of the injury caused by this pest.

The record of this insect in Troy has been even worse than in Albany. It probably made its way to that city about the same time that it came here, and up to 1898 practically no effort had been made to check its ravages. At that time probably 1500 elms had been killed within the corporate limits of Troy and since then many others have suffered a similar fate, though not so many have died the last few years on account of the large amount of spraying done in different parts of the city for private parties. Even now it is possible to go into sections of the city and see within two or three blocks 50 to 100 or more dead elms. These are not aged trees that would have died irrespective of attack by insects, but are in most cases trees which a few years ago were as thrifty and vigorous as anyone could desire.

The story of the city of Watervliet has been virtually that of Troy except that less effort has been made to check the pest; also, as a large proportion of the elms in Watervliet were of the American or white variety on which the beetle does not thrive so readily, the destruction was not quite so rapid. It hardly seems possible, however, that fewer than 1500 magnificent trees have been killed or practically ruined by this insect in Watervliet. A brief note published in December 1900 in one of the Albany papers is of value because it gives the testimony of one who probably had little idea of the true cause of the condition complained of. Under Watervliet items was a short paragraph calling attention to the fact that numerous dead trees were a menace to the safety of pedestrians and stating that they were to be found on almost every block in the city. It might further

have very truthfully added that this condition was almost entirely due to the destructive work of the elm leaf beetle.

Practically the same story has been repeated here and there in small towns along the Hudson river valley where this pest has established itself in force; and, unless the insect is checked on its advent into a village, this is likely to be the record wherever it makes its way.

Inaction means death to the elm. The defoliation of a tree in midsummer is a serious injury since the leaves are breathing organs, and if this occurs for successive years even once a season, the early death of the elm may be expected; when it occurs two or even three times in a summer, it is very easy to see that the danger to the tree is increased manyfold.

Such is the record of the elm leaf beetle in this section. The time to control this pest is not after it has become enormously abundant in a city or village and has seriously weakened or nearly destroyed the majority of the elms; the work should be begun at the outset and in the future the insect prevented from establishing itself in large numbers in any uninfested city or village in New York. Village improvement societies and public spirited individuals interested in the welfare of a community where this beetle occurs would do well to undertake at least an educational campaign against it.

It is comparatively useless to hope that in the course of a few years the pest may not be so destructive. It shows a remarkable vigor and prolificacy in our climate. At Washington D. C. it has been known for a long series of years and is still very injurious. In New Jersey, New York city, New Haven Ct. and other localities it has been found necessary to spray the trees with a poisonous mixture in order to avert serious injury. Parasites, diseases of various kinds and predatory enemies seem to have little effect in reducing its numbers.

Distribution. The insect, as stated by Dr Howard, is found over a large part of Europe, but it is abundant and destructive only in the southern portions of Germany and France and in Italy and Austria. The records of the earlier entomologists indicate that the beetle must have made its way to this country about 1834, because in 1838 it was reported as very injurious to elms in Baltimore Md. Its southernmost range has been given

by Dr Howard as Charlotte N. C., and Prof. Webster records having found it north of Salem Mass. It has made its way as far west as Kentucky, at least. Its progress up the Hudson is interesting to follow, indicating as it does, its distribution along the lines of travel. In 1879[1] it was abundant and destructive at Newburg, 12 years later it was reported to this office from Poughkeepsie, in 1890 from Hudson, in 1891 from New Baltimore and in 1892 it had reached Albany and Troy.

It was found at Mechanicville in 1896 by Dr Howard and that same year larvae in considerable numbers were discovered by the writer at Averill park in the town of Sandlake about 7 miles southeast of Troy, the beetles evidently having been transported thither by the numerous electric cars running to that place. The writer also located the pest in 1900 at Hoosick Falls, Rensselaer co. where it had inflicted considerable injury the preceding year, and he found that it had established itself pretty generally in the towns of Stillwater, Schuylerville, Salem and probably Greenwich. Its presence at Salem and its being found at Saratoga in numbers in 1902 indicate a possibility of still farther progress north, though there were reasons for hoping that it would not be very injurious north of Mechanicville, except possibly in an unusual season.

The occurrence of this insect at Oswego, Hastings and Rochester, brought to my notice through Dr Howard, is a much more serious matter. Prof. C. S. Sheldon of the Oswego normal school states that he has examples of it taken at Oswego in 1896, and Prof. M. H. Beckwith of Elmira reports that he has known it to occur for several years in considerable numbers in his locality. It is also extending its range through the Mohawk valley, having recently been found in considerable numbers at Schenectady.

These last records are of very great importance since they show that the insect has already established itself in several widely separated localities in the western portion of the state and we have no good reason for thinking that it will not, in the course of a few years, be as injurious in that section as it has already proved in the Hudson valley.

1 Unfortunately most of these dates indicate only the time when the ravages of the insect were serious enough to attract the attention of someone, and so only approximately the year of its arrival.

It has spread over a large proportion of Connecticut and into Rhode Island. It had made its way up the Connecticut river valley to Springfield by 1891 and to Amherst by 1895. It has now attained a rather general distribution over the eastern portion of Massachusetts, having been recorded by Mr Kirkland from Worcester and towns in that vicinity, Ayer, Groton and places in the eastern and southeastern part of the state. It has also been found in a number of places in western Massachusetts.

The above records indicate most clearly that this pest has not made its way to all portions of New York state where it may be expected to thrive. The climate of the upper austral life zone seems to agree with the insect, judging from its abundance and the number of broods in Albany and vicinity. The area within the state embraced by this zone is rather crudely represented on pl. 2, which was first published in the 11th report on the injurious and other insects of the State of New York for the year 1895. Briefly, it embraces Long and Staten islands, the valley of the Hudson river north about to Saratoga and a large portion of the northwestern and central part of the state adjacent to Lake Ontario and including Oneida, Cayuga and Seneca lakes and neighboring bodies of water. This insect will probably make its way along the lines of travel to most of the cities and larger villages lying within the above limits. The fact of its having become established at localities not yet included within this zone indicates that it may have a somewhat wider range, though climatic conditions will probably prevent its becoming destructive outside this area.

Description. The work of this pest is so striking as to excite the attention of even the most casual observer. The majority have little idea of the appearance of the insect in its various stages and but faint conception of its life history. In order to control it, it must be recognized and its nature understood to a certain extent.

The parent insect may be recognized by aid of the colored figures (pl. 1, fig. 5, 6) though care should be taken not to confound it with the striped cucumber beetle Diabrotica vittata Fabr., which it resembles in a general manner. The elm leaf beetle is about $\frac{1}{4}$ inch long with the head, thorax and

margin of the wing-covers a reddish yellow. The coal-black eyes and the median spot of the same color on the head are prominent. On the thorax there is a median black spot (not infrequently two triangular ones) of somewhat variable shape and size and a pair of lateral ovoid ones. The median black line of the wing-covers is separated from the broad lateral stripes of the same color by a variable greenish yellow. The elytra or wing-covers are minutely and irregularly punctured and bear a fine pubescence and at the base of each elytron there is an elongated black spot in the middle of the greenish yellow stripe. The markings are usually constant in the adult but the color is quite variable during life and changes more or less after death. Some beetles emerging from winter quarters have the conspicuous greenish yellow stripes of the wing-covers nearly obscured by black. The antennae are a golden yellow with more or less brownish markings. The legs are yellowish with the tibiae and tarsi marked with brown. The under surface of the head and prothorax is yellowish, that of the metathorax and abdomen black.

The orange yellow eggs are deposited in irregular rows side by side, forming clusters of from five to 26 or more on the under surface of the leaf. Several of these are shown natural size in fig. 7. Each egg is somewhat fusiform, attached vertically by its larger end and with the free extremity tapering to a paler, rounded point (pl. 1, fig. 1, 1*a*). Under a powerful lens the fine reticulations of the eggshell are easily seen.

The recently hatched larva (pl. 1, fig. 2) is about $\frac{1}{70}$ inch long, with the head, thoracic shield, numerous tubercles, hairs and legs jet black. The integument between the tubercles is a dark yellow. The tubercles are so large and the hairs so prominent that the prevailing color of the larva at this stage is black. As the larva increases in size and molts, the stiff black hairs become less conspicuous and the yellowish markings more prominent (pl. 1, fig. 3) till the last stage. A full grown larva is about $\frac{1}{2}$ inch long, more flattened than in the earlier stages, with a broad yellowish stripe dorsally and a narrower stripe of the same color on each side, the yellow stripes being separated by broad dark bands thickly set with tubercles bearing short, dark colored hairs. The dorsal yellow stripe is broken on each side

by a subdorsal row of dark tubercles, which increase in size posteriorly. The lateral yellow stripe includes a row of prominent tubercles with dark tips bearing short hairs of the same color. The predominating color of the ventral surface is yellow.

The pupa (pl. 1, fig. 4) is bright orange yellow, about $\frac{1}{5}$ inch long and with a very convex dorsal surface which bears transverse rows of stout, inconspicuous setae.

Life history. In order to control this insect successfully it must be known and its habits understood. Trite though the preceding may appear we have observed men in several places spraying for this pest without accomplishing anything for the simple reason that they did not understand the fundamental principles of fighting insects. In one case the trunk of the tree was sprayed while the grubs were on the leaves; in another paris green and water was used when kerosene emulsion or whale oil soap solution should have been employed.

The beetles pass the winter in attics, sheds, outhouses and various other sheltered places. With the advent of warm weather in the spring they emerge from their retreats and may be found on the walks during the sunny portion of the day or on the windows of houses, vainly trying to escape. Even as early as May 12, numbers of these beetles were to be seen in 1898 on the office windows of the fourth story of the capitol, showing to what a hight they will fly in seeking secure winter quarters. On the appearance of the leaves, the last of April or the early half of May in the latitude of Albany, they fly into the trees and eat irregular holes in the foliage (pl. 1, fig. 9). After feeding some time, and pairing, the orange yellow eggs are deposited on the under surface of the leaves in clusters of about five to 26. The period of oviposition of the overwintered beetles extends from the latter part of May throughout the greater part of June in the vicinity of Albany. The duration of the egg stage in July averages about five days; in cooler weather it may be longer. Feeding and oviposition continue for several weeks in the spring, probably four to six. During this time the beetles consume a large amount of foliage, which is evidently necessary for the development of the eggs, as clusters are laid every day or two till the full complement, which is in the neighborhood of from 431 to 623, is discharged.

As there seems to have been no attempt, at least in this country, to determine the prolificacy of this insect, the following may be of interest. May 31, 1898, two heavy gravid females were isolated, provided with plenty of food, and the eggs removed and counted nearly every day. The results are tabulated below.

Record of eggs deposited by two elm leaf beetles [1]

	FEMALE IN VIAL		FEMALE IN TUMBLER	
DATE	CLUSTERS OF	TOTAL	CLUSTERS OF	TOTAL
June 1	(2)	29	(4)	42
2	....	....	....	....
3	9, 9, 14	32	18	18
4	....	....	....	....
5	....	....	....	....
6	18	18	26, 21	47
7	....	....	....	....
8	15	15	4, 26	30
8 (2 p. m.)	20	20	....	....
9	....	....	27	27
10	20	20	(3 p. m.) 3, 31	34
11	23	23	....	....
12	....	....	....	....
13	11, 13	24	3, 7, 8, 11, 15, 19	63
14	31	31	....	....
15	16, 5	21	14, 27	41
16	28	28	30	30
17	....	....	32	32
18 (absent)	....	....	....	....
19	26, 30	56	10, 26	36
20	2, 6	8	36	36
21	3, 18	21	6, 25	31
22	2, 20	22	4, 31	35
23	27	27	1, 2, 11, 7, 13	34
24	....	....	....	....
25	....	....	....	....
26	....	....	....	....
27	5, 7, 9, 15	36	13, 21, 32	66
28 (beetle dead)	....	....	(beetle dead) 4, 17	21
Totals	....	431	....	623

1 The examinations were made as a rule between 8:30 and 9 a. m. though occasionally, when eggs were seen in the afternoon, they were recorded at the time indicated in the table. The dates in italics fell on Sunday and usually no observations were made then.

The above records have a very vital bearing on remedial measures. From June 1 to 11 from 15 to 47 eggs were generally deposited every other day. The 12th being Sunday the beetles were not attended, but two or more clusters being found with each on the following morning, probably one or more were deposited on Sunday.

The records show that from June 12 or 13 to 23 there was a marked increase in the number of eggs, eight to over 40 being as a rule deposited daily. The record of the beetle confined in the vial indicates a discrepancy greater than the facts warrant. It was impossible to attend the insects on the 18th, so it appears as though two days had been skipped by one beetle and one day by the other, whereas it is probable that there was but a day that the beetle in the vial did not deposit eggs, and the record of the other was probably unbroken, eggs being deposited daily.

During this short period of 10 or 11 days—June 12 or 13 to 23—there were deposited over half the total number of eggs produced during the 28 days the record was kept, the figures being 330 and 338 respectively or an average of over 21 and 30 eggs a day. The average number deposited during the first 11 days of the month are 14 and 18 respectively, which shows that there was an increase in the daily average of one half or more in the case of each beetle after June 11. Those deposited after the 25th were apparently the last efforts of the insects to provide for the perpetuity of their kind, though the quality of the eggs had not deteriorated so far as observable.

The continued oviposition and the prolificacy of the beetles is strikingly shown in this record. They were abroad in numbers by May 12, 1898, and oviposition began about the 25th, so the record of these two individuals is probably lower than the normal as they may have deposited several clusters of eggs before being captured. They were both supplied with fresh leaves from day to day and the eggs removed and counted as soon as detected. The female producing the smaller number of eggs was confined in a small, corked vial, while the other enjoyed the freedom of a jelly tumbler. The difference in condi-

tions undoubtedly had some influence on egg production and the protection from unfavorable weather conditions enabled the beetles to approximate the maximum quota of eggs. The record is of great value since it shows clearly how long oviposition may be continued by a single individual, and shows that if the adult beetles can be killed by thorough spraying any time before this period of greatest reproductive activity, which was about June 11 in 1898, the deposition of a very large number of eggs can be prevented, with correspondingly less danger from the grubs or larvae.

The grubs emerge from the eggs early in June or about five or six days after oviposition, and soon begin to feed on the under surface of the leaves, producing the familiar skeletonized appearance well represented on pl. 1, fig. 8 and pl. 7, fig. 1. This is caused by their eating the softer under part, the upper epidermis and the veins being left. The result of their feeding is so characteristic that it is easy to detect their presence by the semitransparent places in partly eaten leaves and by the skeletonized appearance of the foliage which has been more severely attacked.

The grubs complete their growth in 15 to 20 days in summer (in cooler weather the time may be greatly extended), become restless, forsake the leaves and descend the limbs and trunks to a greater or less extent, seeking proper shelter for pupation. In warm July weather seven days are passed in this state, in September the time is extended to 12 days and in October to 24. The descent of the larvae of the first brood usually occurs in Albany the latter part of June; in 1896 some were observed descending June 19, and beetles of the second brood were taken June 30. The oviposition of the second brood of beetles begins about the middle of July. From that date till late in the autumn it is possible to find the eggs of this insect most of the time in some part of the city. The beetles are naturally attracted by a fresh growth of foliage and it is on the trees throwing out a second or a third crop of leaves or on those not attacked earlier in the season that the eggs of later generations

are found most abundantly. Most of the second brood of larvae complete their growth about the middle of August, becoming adults the latter part of the month. If there is an abundant food supply a partial third generation may be produced. In 1896 numerous eggs were found on elms in Troy the first part of September. This was probably the case in Albany also, as indicated by the large numbers of full grown larvae descending near the middle of October certain Scotch elms which had been practically uninjured in the early part of the season.

This latter occurrence shows most conclusively that the larvae are able to develop on old leaves. The persistent breeding of the insect late in the autumn is shown by the presence of full grown larvae on elm trunks October 31 and by the finding of living pupae on November 7 in 1896, and in 1897 on the still later date, November 16.

Number of generations. The detailed observations of 1896 to 1898 have established beyond question the possibility of two well marked generations annually and the occurrence under favorable conditions of an incomplete third brood at both Albany and Troy. In these two cities the insect has continued breeding as long as the elms afforded sustenance. There is every reason for believing the same to be true in adjacent cities and villages. This is the more remarkable since Dr Smith records but one brood a year, or one and a partial second, at New Brunswick N. J., about 150 miles to the south. As is well known, most insects are more destructive soon after their introduction than in later years. This may be accounted for by the fact that in time native parasites, diseases and other natural checks gradually assert their power on new comers. An insect's freedom from natural enemies might have some effect on its prolificacy, and possibly on the number of generations. It will not only be of interest but of great practical importance to ascertain by observations whether this beetle continues to produce two or three generations yearly in this latitude.

Habits of beetles and larvae. A knowledge of certain habits of this insect are of great value in controlling it. Its hibernation

affords no vulnerable point as the beetles are then too scattered to admit of effective work against them. They feed on the young leaves in the spring for two or three weeks and when abundant may cause considerable injury. The irregular round holes in the foliage (pl. 1, fig. 9 and pl. 7, fig. 2) are an indication of the presence of the beetles, and the amount of injury gives some idea of their abundance. Under exceptional circumstances they may eat the under surface of the leaves, refusing the veins and tough upper epidermis. This is only when the foliage is unusually hard and dry.

One habit of much importance which the adult insect possesses is its disinclination to fly a great distance. Its instinct to remain near one spot is so strong that it spreads very slowly indeed. This is clearly shown in its taking seven years to make its way in numbers from the point where it established itself first in this city to Washington park, a distance of less than 1½ miles. We have repeatedly seen European elms badly defoliated and within 50 feet others of the same species would be hardly affected. In three years (1895-98) it made its way along certain rows of European elms in Albany at the rate of about a block a year.

The larvae are very rarely found on the upper part of the leaf; they appear on the under surface and feed there almost exclusively. It is also evident that in most cases trees are attacked near the top, probably because the foliage of the upper portion is more tender and clean. This is well shown on pl. 3, where the dead tips are high, showing conclusively the preference the beetles have for the younger leaves.

The larvae forsake the leaves after attaining their growth and may be found crawling along the limbs and trunk. If the tree has comparatively smooth bark, a far greater portion make their way to the ground in search of proper shelter while passing through the pupa stage, than if it has a rough bark, which affords numerous secure crevices in which the final changes may be effected. At this time the trunks of infested trees present an interesting sight as thousands of the grubs

crawl up and down the shaggy bark. Occasionally their numbers are so great as to give a distinct character to the surface they are moving over, presenting a peculiar grayish yellow mass of motion enlivened here and there with an orange yellow pupa. A few days later the pupae are more numerous on the trunk and around the base of the tree and adjacent shelter, where they may sometimes be found in golden layers nearly an inch deep, interspersed here and there with a dark larva. Many larvae do not descend the older trees but take refuge in the crevices of the bark, or, if there are overhanging limbs, may drop in numbers from the tips of the branches. Many are content to transform in the gutters, others seek shelter in the crevices of the sidewalks and large numbers cross wide spaces and pile themselves up against a wall or a fence or around any sheltering bush or weed.

SPECIES OF ELMS ATTACKED

It will be observed in most localities that the American elm, Ulmus americana, is comparatively exempt from the attacks of this insect. Sometimes the beetles will make their way from adjacent European elms and seriously injure the American species and, after they have once become established, the but partially migratory habit of the beetle insures attack for a few successive seasons at least. The English elm, Ulmus campestris, and the Scotch elm, Ulmus montana, usually suffer most seriously, while our native species are but little affected. This was very noticeable in Troy and Lansingburg. European elms are numerous in the former place and the work of the elm leaf beetle is conspicuous over the greater part of the city, but as one proceeds northward into Lansingburg American elms abound almost to the exclusion of the foreign species and evidences of the pest are comparatively rare. Again, in 1895 the American elms of Albany showed very little injury by the insect. The next year trees here and there gave evidence of a serious attack and in 1897 a much larger number of the American elms was seriously injured than in the preceding year. The numerous American elms in Water-

vliet have been very severely injured, though the relatively few European elms suffered more.

No species of elm grown in this country is exempt from attack though there is considerable variation in the degree of injury inflicted on the different kinds. The relative liability to attack is apparently a variable quantity in different localities. According to Dr Howard's observations, the American elm suffers more from the insect than does the Scotch, the English species being the favorite, while in both Albany and Troy the injuries to the English and Scotch varieties were about equal, the latter suffering more in many instances, while the American elm was eaten to a much less degree.

AN ASSOCIATED INSECT

The elms, particularly the European species, in Albany, Troy and other places along the Hudson river are most unfortunate in suffering from the attacks of another imported insect known as the elm tree bark louse, Gossyparia ulmi Geoff. This was first discovered in this country at Rye, Westchester co. N. Y. in 1884, on the nursery stock of Mr Charles Fremd. It is now known to occur in a number of localities in the Hudson valley, being generally distributed over Albany, Troy and adjacent towns, and ranging north to Greenwich. It has been received by the writer from Ogdensburg, St Lawrence co. It has also become established in the vicinity of Boston and at Amherst Mass. and Burlington Vt. Other recorded localities are Washington D. C., Michigan agricultural college, Carson City Nev. and Palo Alto Cal.

Injuries and characteristics. The injurious nature of this bark louse in our latitude has been abundantly demonstrated the past few years in conjunction with the work of the elm leaf beetle. The affected trees are easily recognized in midsummer by their blackened appearance, which is caused by a growth of the fungus Coniothecium saccharinum Peck in the honey dew covering the foliage, the limbs and the ground beneath. The minute drops of the secretion may easily be seen in sunlight falling in showers from the clusters of insects,

giving an idea of what a drain this species must be on a tree's vitality. The limbs which have harbored the bark louse for a few years begin to die, the tree itself shows signs of weakness, and when it is attacked by both the elm leaf beetle and the bark louse, its destruction follows in a few years.

Description and life history. The adult females are rather conspicuous during April, May and June. They may be found on the under sides of the smaller branches, frequently clustered in masses and appearing not unlike certain lichens. Each at this time is about $\frac{1}{16}$ inch long, oval in outline, with the extremities slightly pointed, and if crushed causes a reddish stain from the contained ova. The body is surrounded by a mass of white, woolly secretion and the segmentation is also indicated by the same substance, as shown in pl. 8, fig. 1. The minute yellow young make their appearance early in July and soon settle for a time on the greener twigs and along the principal veins of the leaves. Occasionally a greenish twig will be almost yellow on account of the large number of young settled on it. In the autumn the back of the partly grown bark louse is covered with spiny processes which excrete a protective, whitish waxy matter. Most of the insects forsake the leaves at this time and settle for the winter in crevices of the bark. The females molt for the last time early in April, and the males spin their oval cocoons (pl. 8, fig. 2). The delicate, four winged reddish male is rarely seen, though of particular interest from its presenting a partially developed form known as the pseudimago. The latter was present in large numbers May 10, 1900, while the perfect males were not found till the 21st.

Means of distribution. As the slender males only are winged, the insect is dependent largely on various outside agencies for its distribution. It has most probably been carried to Nevada, California and other distant localities on infested nursery stock, but this does not explain its general occurrence in such cities as Albany and Troy. Its distribution in these two places, at least, appears to have been largely effected by the aid of the English sparrow and other birds; the active young can easily

crawl on the foot of a bird and thus be transported from one tree to another. Other insects may also to a certain extent transport them and some, falling with the leaves, might successfully make their way up another tree; the chances, however, are against the latter method.

SECONDARY ATTACKS BY INSECTS

It is well known to students of nature that an enfeebled tree apparently invites attack by certain insects which seem to find

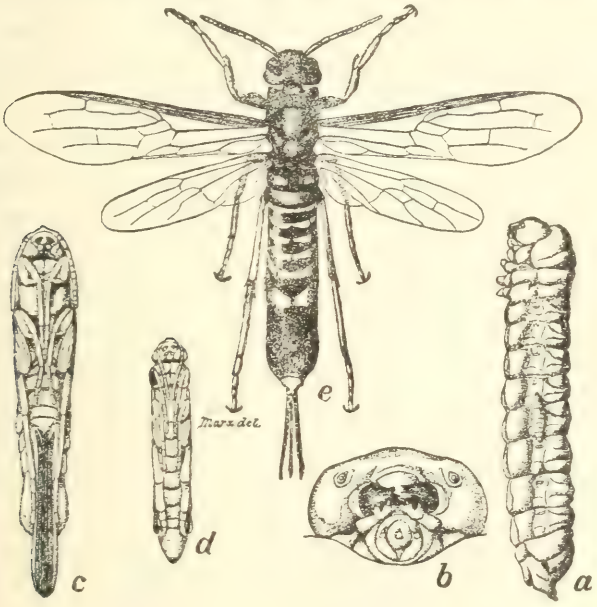

Fig. 1 Tremex columba: *a*, larva showing the Thalessa larva fastened to its side; *b*, head of larva; *c*, pupa of female; *d*, male pupa; *e*, adult female; all slightly enlarged. (After Riley, *Insect life*, v. 1, fig. 39)

in the unhealthy tissues conditions peculiarly fitted for their development. The ravages of the elm leaf beetle have encouraged certain of these pests to a marked degree. One of the most common and injurious is known as the pigeon Tremex, Tremex columba Linn. This insect is a magnificent four winged fly about 2 inches long, with a wing spread of 2½ inches and a prominent horn at the extremity of the abdomen from which it gets the common name of horn tail. It may be recog-

nized by its cylindric dark brown abdomen with yellow markings as represented in fig. 1.

The female deposits her eggs in the trunks of sickly trees, where the larvae run large cylindric burrows. Many elms in both Albany and Troy show numerous holes caused in this way. This borer has a deadly parasite in the lunate long sting, Thalessa lunator Fabr. This beneficial insect is of great aid in keeping the Tremex under control. The remains of 13 ovipositors were found by the writer in the trunk of one small elm. In their efforts to reach the numerous borers in the tree, the females had driven their long ovipositors so far into the wood that they were unable to withdraw them.

Another insect which infests debilitated elms is known as the elm borer, Saperda tridentata Olivier. The larvae of this beetle run their burrows under the bark and in the sapwood of the trunk, not many penetrating to a greater depth than an inch. Their burrows frequently become so numerous as to girdle trees two or three feet in diameter. An infested elm may be recognized by the patches of unhealthy bark; in case of a bad infestation large pieces become loose and scale off easily. The beetle is usually less than $\frac{1}{2}$ inch long, and of a dull slate color, with the thorax and wing-covers margined with dull orange (fig. 2).

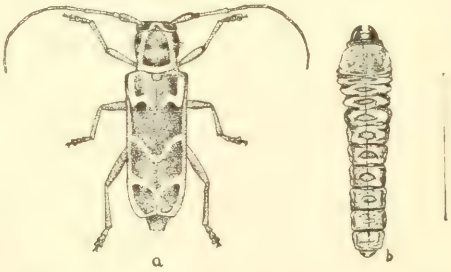

Fig. 2 Saperda tridentata (twice natural size)

NATURAL ENEMIES OF ELM LEAF BEETLE

The natural checks serving so well to keep thousands of insects under control which otherwise would be very destructive, are unable to reduce the numbers of this beetle to a relatively harmless figure. One of the more important natural agents is

the fungus Sporotrichum entomophilum Peck, which has been observed developing on many beetles in this city. Like the disease of the chinch bug caused by the allied fungus, Sporotrichum globuliferum Speg., the one attacking the elm leaf beetle requires moist atmosphere for its development. Beetles in close breeding jars, under the bark of trees or in similar damp places succumb readily to the disease. Climatic conditions are not ordinarily favorable to the rapid growth of this fungus, so it has a relatively slight value as a natural check on the elm leaf beetle.

Several insects are known to prey on this pest, its pupa or its larva. Three beetles, Platynus punctiformis Say, Quedius molochinus Grav. and Chauliognathus marginatus Fabr., feed on this species as recorded by Riley. A fly, Cyrtoneura stabulans Fall., destroys many pupae in Washington. In this latitude the half grown larva of Podisus spinosus Dallas has been observed with an elm leaf beetle grub on its extended beak, and it probably preys extensively on the larvae, since in Washington all stages are known to attack it. Mr Kirkland has recorded two other species, Podisus serieventris Uhler and P. placidus Uhler as preying on this pest. He also found Stiretrus anchorago Fabr. feeding upon the larvae. A small capsid, Camptobrochis grandis Uhler, sucks the eggs. Larvae of lacewing flies, also called aphis lions, are frequently found on leaves with the young of the elm leaf beetle, and are reported by Riley to feed on both eggs and larvae. Mites have been observed by the writer near egg clusters that had suffered injury. This insect finds an enemy in the southern portion of its range in the praying Mantis, Stagmomantis carolina Linn. It is very probable that the European praying Mantis, Mantis religiosa Linn., recently established in a number of localities in the state through the efforts of the writer, will also prey on this injurious beetle.

Though we have seen nothing of the kind in this vicinity, one gentleman affirms most positively that the English sparrow

feeds on the elm leaf beetle larvae, having repeatedly observed it picking them off the trunks of the trees. If the sparrow has this habit, it offsets to a certain extent its many bad features.

REMEDIES

The most satisfactory method of controlling this insect is by poisoning the foliage. The objection heretofore urged against this means has been the expense, and it still applies to a certain extent in the case of the private individual with but few trees to care for. Aside from the cost of the necessary apparatus, the operation of spraying even large shade trees is not so expensive as is commonly supposed; and valuable results may be obtained with a comparatively inexpensive outfit, though the cost for each tree may be increased.

Cost of spraying elms. We have taken some pains to ascertain the precise cost of spraying a tree in the hope of encouraging those to whom the expense seems a serious item. It is pleasant to record that it is much lower than had been supposed previous to the time this bulletin was originally prepared; more recent data confirm the fact. Dr Smith, of the New Jersey agricultural experiment station, kindly supplied the following data in 1898. The elms on the college campus at New Brunswick are 50 to 75 feet high and were sprayed at odd times by the janitors, about an hour being required by two with force pump, tank and ladders to treat one tree. The poison necessary for each spraying was worth about 6c. It will thus be seen that the cost for each tree would be between 36c and 56c, varying with the price of labor. In New Brunswick the trees were sprayed at a contract price of $1 for the season, the understanding being that they were to receive three treatments if necessary. The contractor prepared the outfit, furnished the material, did the spraying at the price mentioned and had a neat margin remaining.

The cost of spraying elms in Albany in 1898, aside from wear and tear of the apparatus, was about 15c a tree for each spraying. This average was based on one or two days work and probably would not hold for the season. It is very likely that it would have paid to give each tree a little more time, which

would have brought the average cost up somewhat. The elms of Albany range from 20 to about 70 feet in hight, though most of them are over 50.

The average cost of one spraying in Albany in 1900 was about 22c a tree. The spraying was done with an apparatus, to be described later, and under civil service regulations, which require men to work but eight hours a day. Two power spraying outfits under one foreman's direction constituted the force. It would be possible in private work to reduce the force somewhat and have one man do duty both as motorman and driver. A little more selection could also be exercised and possibly more efficient men secured than can usually be obtained under civil service regulations.

Mr H. W. Gordinier of Troy found that in contract work in the village of Lansingburg, where he sprayed all the trees, the average cost a tree for each spraying was 23c. This figure, however, was raised considerably in his work in Troy where the trees were sprayed at the expense of private parties and there was necessarily much running hither and thither; under these conditions it ranged from 50c to 60c a tree, the cost depending on the size and the number in one locality.

The saving in cost shown by the above figures, not to mention the greater benefit to the public, particularly in the poorer sections of a city where shade trees are most needed and where they are usually neglected, is a strong argument in favor of such spraying operations being done under village and municipal authorities. The more general and thorough the work, the more satisfactory the results.

Proper apparatus. In order to do this work successfully one must possess a force pump capable of throwing a stream some distance, a number of feet of hose and a nozzle that will discharge a rather fine spray. There must also be something to hold the poisonous mixture and a ladder facilitates the work of application greatly.

One of the best arrangements for hand work is most probably found in the spraying outfit on wheels so that it can be readily

moved from place to place (pl. 6). In most cases this takes the form of a box or barrel to which a force pump is firmly attached, and is either provided with wheels or designed to be placed in a wagon. It is necessary to have 25 to 50 or more feet of $\frac{1}{4}$ or $\frac{1}{2}$ inch hose when spraying tall trees, while the addition of a 10 to 25 foot metal extension adds materially to the value of the apparatus. It is also necessary to have a good nozzle that will not clog, but will produce a fine spray and can be quickly adjusted to throw a coarse spray some distance if necessary. Such an outfit is of great service to any individual having considerable spraying to do and it could undoubtedly be used to advantage by those desiring to make a business of spraying in a small way, as for example the treating of trees here and there for those in cities wishing their trees sprayed and not willing to purchase the necessary apparatus.

In the extended work against this insect conducted by cities and villages it is desirable to have apparatus that will admit of more rapid work. This has led to the refitting of retired fire engines and the designing of more or less cumbersome outfits for the purpose. In all cases these makeshifts have been successful, though they are not so satisfactory in operation as those specially fitted for the purpose. One of the best forms of apparatus yet designed for spraying trees is that constructed under the direction of Dr E. B. Southwick, entomologist of the department of public parks of the city of New York. This is the form used in Albany. The whole outfit is represented on pl. 5. It consists of a Daimler gasoline motor operating a Gould force pump. The motor and pump, weighing but 300 pounds, can be placed in the bottom of a spring wagon along with the 100 gallon tank containing the poisonous mixture. This motor has the advantage of being almost noiseless in operation and is scarcely noticed by passing horses. It is very inexpensive to operate, as a gallon of gasoline is sufficient for a day, and it requires so little attention that a tyro can run it. The smallest size Gould three piston pump is the one used with the motor, though Dr Southwick now recommends a larger one

in order to utilize the power more fully. A complete power spraying outfit, aside from horse and wagon, should not cost over $500, the price naturally varying with market conditions and quality of materials used. Four lines of hose can easily be supplied though in most places in Albany not more than two can be used to advantage.

Some other apparatus in addition to that usually supplied with spraying outfits is necessary. Several ladders or some convenient arrangement for getting up into trees is almost essential unless the spraying wagon has one of the elevating platforms such as are used by electric car companies on repair outfits. Two power spraying outfits constructed for the village of Saratoga in 1899 were provided with these elevating towers and these were found to be very effective and economical. The cost of spraying for the forest tent caterpillar which, by the way, need not be done so carefully as for the elm leaf beetle, was but 17¼c a tree and considerable of this saving was attributed to the elevating towers. In this instance 5667 large maple trees were sprayed and practically all in the village were treated, thus enabling the operators to save time in every possible manner.

Time and manner of spraying. Though it is easy to state the proper time to spray, in many cases it is exceedingly difficult to have the recommendations properly carried out. The beetles feed in the early spring on the young foliage for a considerable time before any eggs are developed and eat for a day or two between the deposition of the clusters. It therefore follows that if the partly unfolded leaves are sprayed at this time the beetles can be killed and the production of eggs prevented to a large extent. This is very desirable, for if at all numerous the beetles injure the foliage considerably. A number of arsenical poisons can be used in the control of this insect with very good results but the experiences of the last four years have demonstrated the great superiority of arsenate of lead for this work. This is a preparation made by combining acetate of lead and arsenate of soda. It may be prepared as follows: dissolve 11

ounces of acetate of lead in four quarts of water in a wooden pail and four ounces of arsenate of soda (50% purity) in two quarts of water in another wooden pail. As the acetate of lead dissolves rather slowly in cold water the process can be hastened by using hot water. Pour the solutions in enough water to make 80 gallons.

It was at first advised to prepare this poison in the manner indicated above but the difficulty of getting chemicals of the same grade of purity year after year and the ease with which dealers in these substances may prepare this insecticide, has led to the introduction of several brands of arsenate of lead in the prepared paste form. These preparations have been found more convenient than the homemade article and generally speaking their use is advisable. The crystalline arsenate of lead is not in proper condition to use as an insecticide and therefore it is necessary to get the specially prepared article.

The value of arsenate of lead over other poisons lies in its adhesiveness to the foliage—it frequently remains on the leaves nearly an entire season in spite of many rains—and in the fact that it can be applied in almost any amount without danger of injuring even the most delicate leaves. Paris green, london purple and similar arsenical poisons operate more quickly than arsenate of lead but they are also readily washed off by rains, and in the case of an insect like the elm leaf beetle, which feeds for an extended period, it is much better to apply the more adhesive preparation even though the cost be somewhat greater. The necessary amount of prepared arsenate of lead is usually stated on the package and it varies somewhat with the method of manufacture.

The first spraying, as stated above, should be given as soon as the leaves commence to develop and usually it will be necessary to repeat the treatment at the time the young larvae begin their work, though after the insect has once been brought well under control in a locality, possibly a single thorough spraying each year for the beetles may be sufficient. Experience has shown that in a locality where all the elms are thor-

oughly sprayed it may not be necessary to treat them again for two years.

The second spraying should occur at the time the young are beginning to hatch, which in this latitude is about the first week in June. The poison should be applied to the under surface of the leaves. This is because the larvae feed only very exceptionally on the upper surface of the foliage or even break the upper epidermis. Consequently it is impossible to poison them unless the insecticide be thrown on the under surface. The larvae succumb to the poison more readily than the beetles and it is therefore not necessary to use so concentrated a mixture in the later sprayings.

The necessity for subsequent sprayings depends largely on the manner in which the previous work has been done. Much depends on the man who holds the nozzle, even though he be under the eye of one who understands the business. The mixture should be applied evenly in a rather fine spray and so far as possible to every leaf. If the poison be applied thoroughly and at the right time, two sprayings should be ample to keep the beetle under control. Otherwise it may be necessary to spray for the second and even the third brood. The proper time for later arsenical sprayings must be determined by observation. The spraying for the second brood should be done in Albany and Troy about the latter half of July.

A PALLIATIVE MEASURE

It frequently occurs that for some reason spraying with poison can not be resorted to readily. The habits of this insect are such that at certain times large numbers can be destroyed with little labor, as has been pointed out year after year. But it is well to understand that such a measure is not a remedy in the true sense of the word; it is simply a palliative. Everyone interested in the welfare of his shade trees should at least destroy the thousands of larvae and pupae on the trunks or around the base of infested elms. If the base of the trees, their surroundings and other adjacent shelters be thoroughly drenched with boiling water or sprayed with kerosene, kero-

sene emulsion or some similar preparation, thousands of these insects can be killed. As it requires six or seven days for the larvae to pass through the pupal stage to beetles, this operation need not be performed oftener than once in five days to insure the destruction of all that have pupated within reach of such a measure. The nearly simultaneous descent of the grubs is very favorable to this way of checking the insect and reduces the necessary labor to a minimum. To make this method more effective, it has been recommended to inclose a limited smooth area around each infested tree, preferably cemented, boards being arranged to prevent the larvae from escaping to shelters where they could less easily be destroyed. Such an inclosure might be advisable around small trees with relatively smooth bark and no overhanging limbs, but it would hardly pay to treat larger trees thus on account of the large number of larvae pupating in the crevices of the bark or dropping from the tips of overhanging limbs. The great objection to fighting the insect at this stage is that the injury has already been accomplished, but to do even this is much better than to allow it to go on unchecked, because it must have some influence on the future abundance of the beetle. The destruction of larvae and pupae around the base of the trunk may well be undertaken to supplement the spraying and thus secure the destruction of the largest possible number of the insects.

USELESS MEASURES

Though the life history of this beetle is well known, at least to entomologists, it is surprising how people will cling to some false idea, gained they know not where, of the method of fighting this or some other insect. One of the most persistent of these fallacies is that cotton placed around the trunk will protect a tree from the elm leaf beetle. Under certain conditions a band of cotton, tar or other substance will protect trees from some insects, but never from the elm leaf beetle. It should be understood that the parent insect flies up into the tree, feeds for a time and then lays the eggs from which the grubs emerge to commence their injurious work. The band can not have the

slightest influence in protecting the elm. It is only when the grubs are full grown that they are found on the trunks and then only on their way to seek shelter on the ground during pupation. If a band of any kind blocks the way to the ground they may transform on the tree or even in the meshes of the cotton band and fly away later. If the band is of tar or sticky fly paper large numbers of the grubs may be caught on its surface, but there will hardly be enough to pay for the trouble incurred.

Another so called remedy for the elm leaf beetle consists in boring a hole to some depth in the trunk, nearly filling it with sulfur or other preparation and then inserting a plug. This method of treatment or some modification of it is being brought forward every few years as one of the "sure cures." The destruction accomplished by the elm leaf beetle has encouraged at least one unscrupulous firm to advertise a modification of this method as a sure cure. The Elm inoculation company in 1895 treated many elms in Connecticut and 150 for one man in Westchester county, N. Y., charging 50c or more a tree. Chemical analysis showed their secret preparation to be nothing of value. This or any similar treatment may well be regarded suspiciously by any would-be investor. It is hardly necessary to add that such a remedy has no basis in scientific fact and similar recommendations should not be heeded unless they come through such channels that their authenticity can not be doubted.

REMEDIES FOR ASSOCIATED INSECTS

The elm bark louse belongs to Hemiptera, that large order of insects which take food only by suction through a fine proboscis from the underlying tissues. It is easily seen therefore that a poison applied externally to the tree, as for example paris green, would have no effect on this pest. The best remedy is one of the contact insecticides, preferably kerosene emulsion or whale oil soap solution. This should be sprayed on the under surface of infested limbs and foliage when the tender young are appearing. Kerosene emulsion may be prepared by dissolving a half pound of hard soap in a gallon of

boiling water; while yet hot add two gallons of kerosene and emulsify thoroughly by passing it rapidly through a force pump till it is white and has a creamy consistency. For the young, one part of this emulsion to 10 parts of water should be effective. Whale oil soap solution may be used in the same manner, a pound of the soap being dissolved in four gallons of water. These preparations could be applied in the autumn after the dropping of the leaves, but in this case the solutions should be about four times as strong. Small trees may be cleaned with a stiff brush, which might be made more effective by dipping it in one of the above solutions from time to time.

Preventive measures against borers are of much more importance than any remedies that can be applied. The trees should be kept in as vigorous a condition as possible and careful watch maintained for the first signs of boring, indicated by the detached grains of wood popularly termed "sawdust." When indications of their presence are found the larvae should be dug out if possible. A badly infested tree should be cut down and burned to prevent the insects from developing and the adults from making their way to other trees.

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EXPLANATION OF PLATES

PLATE 1[1]

Elm leaf beetle

Galerucella luteola Müller

FIG.

1 Cluster of eggs, much enlarged

1*a* Side view of single egg, still more enlarged

2 Recently hatched larva or grub, much enlarged

3 Full grown larva or grub, much enlarged

4 Pupa, much enlarged

5 Overwintered beetle, much enlarged

6 Fresh, brightly colored beetle, much enlarged

7 Leaf showing eating of larvae or grubs and a few holes eaten by beetles, eggs in clusters, cast larval skins and full grown larvae, natural size

1 Executed from nature, under the author's direction, by Mr L. H. Joutel of New York city, and reproduced from the 5th report of the commissioners of fisheries, game and forests through the courtesy of the commissioners.

FIG.

8 Leaf nearly skeletonized by grubs or larvae and on it two cast larval skins, natural size

9 Leaf showing holes eaten by beetles, natural size

PLATE 2

Upper austral life zone in New York state, which is the area likely to become infested by the elm leaf beetle

PLATE 3

Work of elm leaf beetle on Elm street, Albany, taken 15 June 1898.

PLATE 4

Work of elm leaf beetle on Jacob street, Troy, taken 15 June 1898.

PLATE 5

Power spraying outfit at work in Albany, taken 15 June 1898

PLATE 6

Hand spraying outfit at work in Albany, taken 15 June 1898

PLATE 7

1 Work of elm leaf beetle larvae, showing characteristic skeletonizing

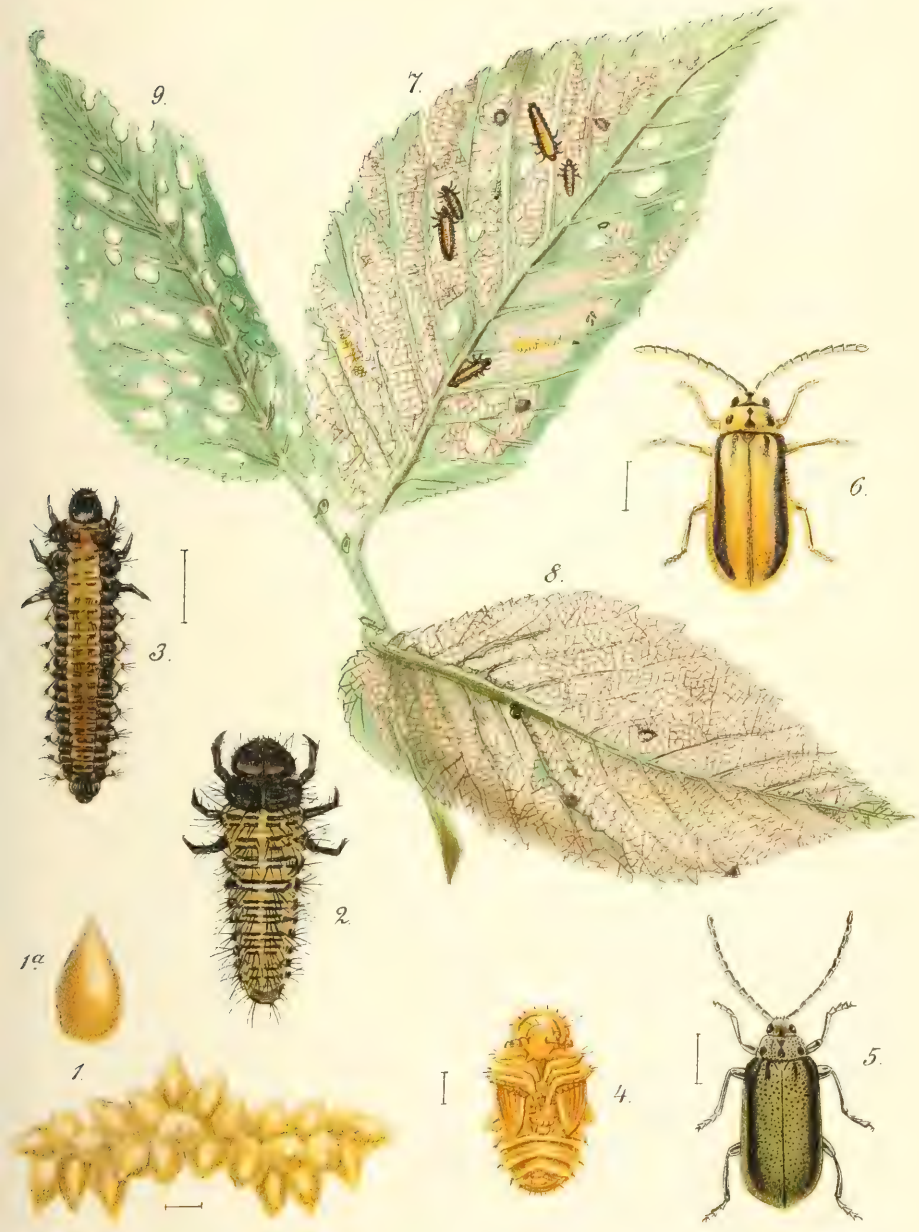
2 Work of elm leaf beetles, showing characteristic holes (original)

PLATE 8

Gossyparia ulmi Geoff.

1 Females, slightly enlarged

2 Cocoons of males, three times natural size

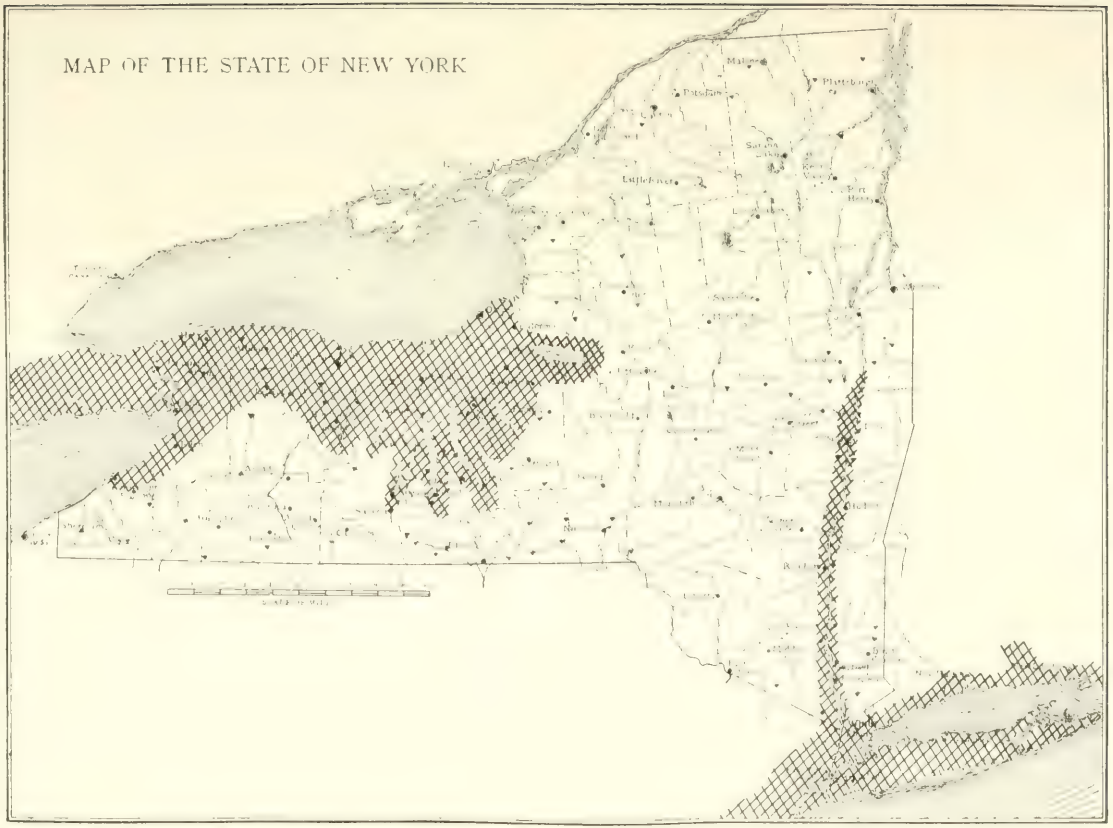


L. H. Joutel, 1900

ELM LEAF BEETLE

James B. Lyon, State Printer

(Reprint from 5th report of commissioners of fisheries, game and forests.)



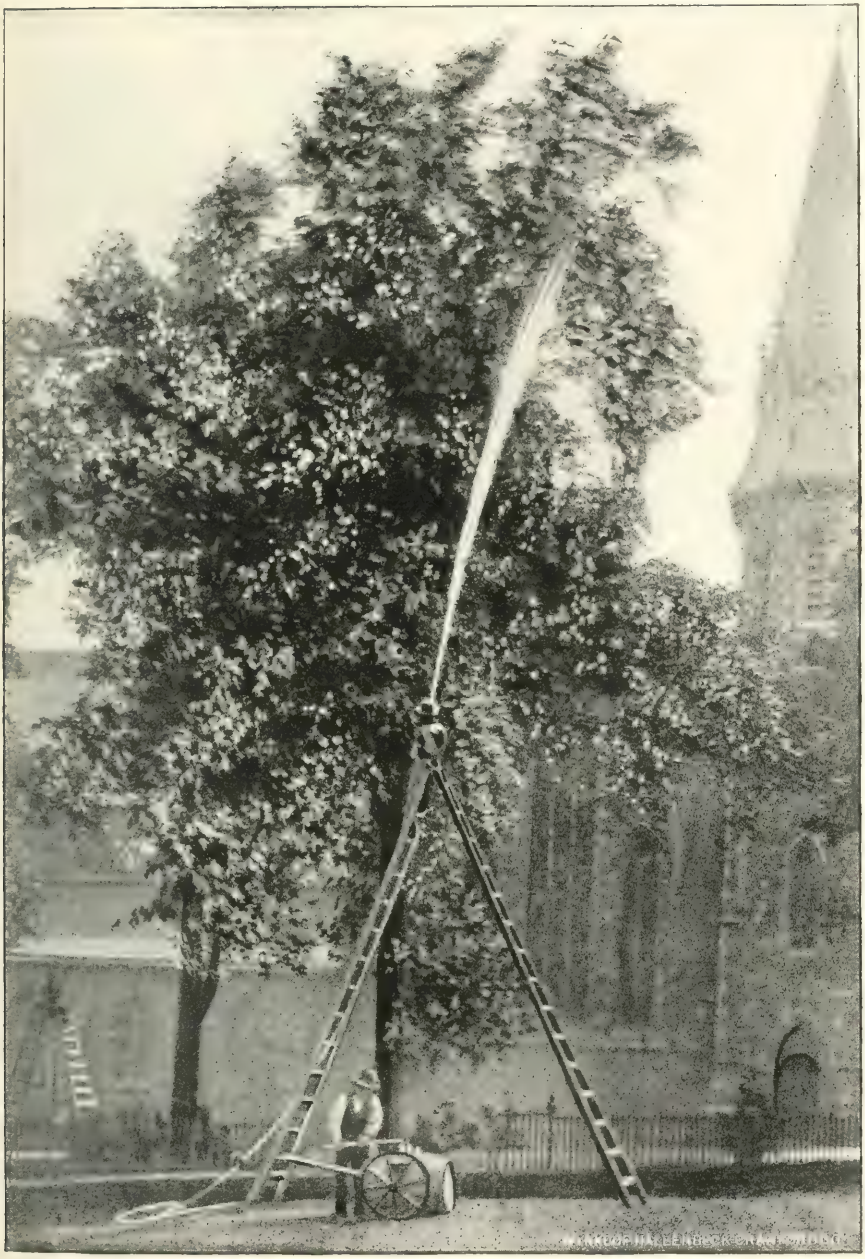
Upper austral life zone in New York state, which is the area likely to become infested by the elm leaf beetle (After Lintner)

Work of elm leaf beetle on Elm street, Albany Photo 15 June 1898

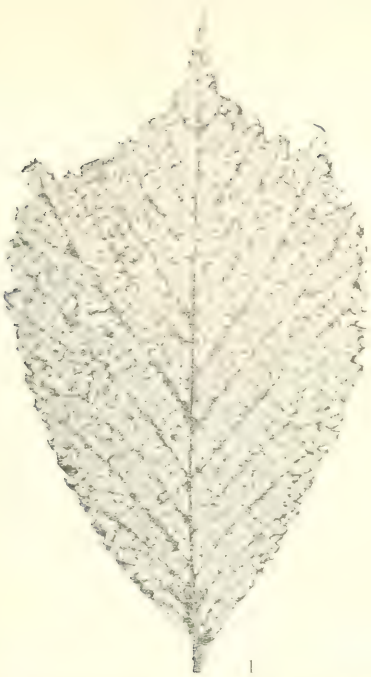
Work of elm leaf beetle on Jacob street, Troy Photo 15 June 1898

Power spraying outfit in operation

Photo 15 June 1898



Hand spraying outfit in operation Photo 15 June 1898



1

2

Elm leaf beetle work.

2

1

Elm bark louse

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FREDERICK J. H. MERRILL Director
EPHRAIM PORTER FELT State Entomologist

Bulletin 59

ENTOMOLOGY 16

GRAPEVINE ROOT WORM

BY
EPHRAIM PORTER FELT D.Sc.

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Frederick J. H. Merrill Director
Ephraim Porter Felt State Entomologist

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ENTOMOLOGY 16

GRAPEVINE ROOT WORM

PREFACE

The grapevine root worm has proved itself such a destructive enemy of vineyards in the Chautauqua grape belt and so little has been done to control it, that it was deemed advisable last spring to undertake an investigation of this insect, particularly as the entomologist's aid had been solicited on several occasions. This bulletin is issued at the present time not that the investigations are complete, but because the subject is of such vital importance that our growers should have all available information at their disposal. Some valuable facts have been ascertained during the past season and it is hoped that future investigations may result in demonstrating some satisfactory method of controlling this very serious enemy of the vineyardist.

Through the courtesy of the Hon. C. A. Wieting, commissioner of agriculture, the entomologist has been able to avail himself of the services of Mr J. Jay Barden, a San José scale inspector in the western section of the State. Mr Barden has cooperated with the writer very efficiently and most of the field investigations were carried on with the assistance of this gentleman. The breeding cage and other office experiments have been conducted under the writer's direction by his first assistant Mr C. M. Walker aided by the second assistant Mr D. B. Young. The author is also under obligations to Prof. Percy J. Parrott, entomologist of the Ohio Agricultural Experiment Station, and

Prof. A. F. Burgess, chief San José scale inspector of Ohio, who kindly accompanied him in his investigation of conditions in that state.

E. P. Felt

Albany N. Y. September 1902

GRAPEVINE ROOT WORM

Fidia viticida Walsh

Ord. *Coleoptera:* Fam. *Chrysomelidae*

INTRODUCTION

The vineyardists in the Chautauqua grape belt are confronted by a serious condition in the presence of the above named insect. This pest has in recent years caused enormous damages in the Ohio grape belt and is now established in large numbers in the vicinity of Ripley N. Y. and has obtained a foothold over a large area. Messrs Walter Northrop and F. A. Morehouse estimated last spring that over 80 acres of magnificent vineyards had already been destroyed in the vicinity of Ripley. We consider this insect a much more serious enemy of the vineyardist than the grapevine leaf hopper, the work of which has been so apparent and destructive in the last two or three years. The leaf hopper undoubtedly causes much mischief, but as its operations are confined to the leaves, the amount of damage is easily seen and, when necessary, steps may be taken to control the pest. The root worm, on the other hand, inflicts its most serious injuries under ground where its operations can not be readily observed, and in a great many instances a vine is nearly ruined before the grower notices any trouble. The secrecy of this insect's work and the fact that the grubs operate on the large roots, where a small amount of girdling is fatal, constitute the most dangerous features of this pest.

The vineyardists of the Chautauqua grape belt should be thankful for the very wet season just past, because it has undoubtedly enabled the vines to recuperate to a considerable extent from previous injuries and has also prevented serious damage by the root worms in 1902.

Area infested. Ripley appears to be the center of this insect's most destructive work, though it has been found generally present in small numbers in many vineyards where little evi-

dence of serious injury occurs. The pest very probably made its way into the Chautauqua grape belt from Ohio and is present in greater or less numbers as far east as Fredonia, if not farther. It has not been met with by us in numbers in other grape-growing sections.

Signs of the insect's presence. The more destructive work of this pest is somewhat difficult to detect, but indications of the presence of the beetles are so characteristic that there should be little trouble in locating them. The peculiar chainlike areas, represented on plates 5 and 1, figure 2, are very characteristic of the insect and differ so much from the work of most other pests that no difficulty should be experienced in identifying it. The beetles exhibit a decided preference for smaller vines, and the general appearance of some very badly eaten ones is shown on plate 4. The feeding of the beetle is usually the first visible indication of its presence and is rarely accompanied at the outset by signs of material injury. As the attack progresses and the work on the roots becomes more injurious, the development of the fruit is severely checked and the bunches may be less than half their normal size. The growth of wood is also much reduced and vines which are very badly infested may die in midsummer. Cases were brought to the writer's attention where plants which had grown over 6 feet of wood the preceding summer, wilted in June and died. Infested vines as a general thing become less thrifty, develop less and less wood yearly till finally there is not enough to tie up. A portion of a vineyard very seriously injured and where there is not wood enough to tie up is represented on plate 2. This condition rapidly becomes worse and soon the vines are simply a small mass of foliage resting on an old stump as represented on plate 3.

The depredations of this pest are much worse and usually first apparent on light sandy or poor soils, and in particular on gravelly knolls. The insects seem to thrive under such conditions and a deficient growth should lead to immediate investigation. Vines on rich clay soils, in our experience, sustain comparatively little injury from this pest and this appears to be the case in Ohio.

The condition of the roots also affords a clue to the identity of the depredator. The young grubs eat away the small feeding roots while the larger individuals gnaw the bark, particularly from the under side of the larger roots. They frequently eat away long strips, as represented on plate 1, figure 5, though occasionally a single grub may pursue a somewhat sinuous path.

A native species. This serious pest of the vineyards is not, like many of the forms so injurious to agriculturists, an imported insect. It has long been known to occur in this country and its work on wild grapevines was observed before its depredations attracted notice in our vineyards. This insect may develop into a general pest of the grape and perhaps in time come to be as well known as the very destructive Colorado potato beetle, which is familiar to almost every farmer. It is very probable that this grape enemy was able to exist only in relatively small numbers on wild vines and hence was rarely very injurious. It seems to have developed a great fondness for some of our cultivated varieties and the growing of these in large areas has enabled it to increase to an almost unparalleled degree. This may perhaps be cited as one of the cases where the devotion of extensive tracts to one crop has resulted in a species formerly harmless becoming very destructive.

It is interesting to note in this connection that the species is by no means new to New York State. There are examples of the beetles in the private collection of the late J. A. Lintner, which were taken in Schenectady in 1880 and on Virginia creeper at Albany in 1882, and yet so far as known there is no record of the species proving destructive in this section. The writer also met with the insect at Albany in considerable numbers on Virginia creeper in 1901, and though he has frequently visited vineyards in the vicinity, no signs of the insect were observed. It is very possible that the death of vines in early years here and there may have been caused by this beetle and attributed by the growers to other causes, as was the case before Professor Webster discovered the identity of the depredator in Ohio.

Allies. This species belongs to the family of leaf eating beetles, known as the Chrysomelidae, a group which comprises some of our most serious insect enemies. To it belongs the notorious elm leaf beetle, Galerucella luteola Müll., a species which has destroyed thousands of magnificent shade trees in the Hudson river valley. The two asparagus beetles, Crioceris asparagi Linn. and C. 12-punctata Linn., are well known enemies to the grower of this succulent vegetable. The familiar yellow and black striped squash bug, Diabrotica vittata Fabr. is another ally of this destructive grape pest, which is sometimes aided in its deadly work by the steely blue or grapevine flea beetle, Haltica chalybea Illg., a species which has caused great injury in some New York vineyards during recent years. A number of other related forms nearly as injurious as those named could be easily listed. These destructive allies are mentioned in this connection simply that the grape grower may have some idea of what related species can do, and while this pest may not prove so destructive as any of these, it has already demonstrated its ability to cause much mischief. We see no reason at present for thinking that the history of this insect in Ohio may not be duplicated in the Chautauqua grape belt, and perhaps in other sections of the State where this fruit is largely grown.

Present conditions in Ohio. The destructive work of this serious pest has been known in Ohio for some years. It was first brought to the attention of Professor Webster in 1893. The similarity of conditions existing between the Ohio grape belt and the Chautauqua region led the entomologist to believe that valuable data could be secured by personally investigating the present status of the insect in Ohio. This interesting section was visited about the middle of September and much valuable information secured through the kindly cooperation of Prof. P. J. Parrott, entomologist of the Ohio Agricultural Experiment Station, Prof. A. F. Burgess, chief San José scale inspector, and a number of prominent growers. The local knowledge of conditions possessed by the two gentlemen named enabled us to

visit the sections of most importance with very little loss of time. Some very precise and significant statements were obtained from Mr T. S. Clymonts of Cleveland O., who is not only a grower but also a dealer and one who undoubtedly has as good a general knowledge of local conditions as any one in that section. He states that in the Ohio belt, extending east and west of Cleveland, from Painsville to Avon and reaching back 5 miles from the lake, there has been a reduction in shipments of fully two thirds during recent years. In 1894 2000 carloads of grapes were shipped from that section. This was reduced in 1900 to 900 and in 1901 to 600. Mr Clymonts estimated the output for the present year as not over 500 carloads.

He states that this reduction is due to various causes, the principal ones being the ravages of the grape root worm, the destruction caused by rot, and the prevailing low prices. He attributes fully one third of the entire reduction to the beetles' work and instanced a number of cases where vineyards of considerable size had been killed by the operations of this pest. He mentioned one vineyard of 60 acres, another of 25 acres, and stated that innumerable small pieces had been destroyed by the work of this insect. He states that the yield of one 60 acre vineyard has been cut from 10–12 carloads to 35–40 tons by its operations. Mr Clymonts observations led him to think that as a rule the younger vineyards, specially those planted in the last 10 or 12 years, suffered most and that the old ones escaped with comparatively little harm. The most destructive work observed by him has been on sandy soil, or on ridges in other pieces. He also states that vines set in an infested vineyard to fill vacancies do not thrive and are usually killed by the insect.

Mr J. W. Maxwell of Euclid states that 50% of the vineyards are dead in that section and that in his opinion a large proportion of these have died as a result of the operations of this insect. His crop of grapes in a large vineyard was reduced fully one fourth, the most of which he attributes to this pest. He states that the Wordens and Brightons are killed first, while the Concords and Catawbas are not so badly injured.

Mr W. H. Slade of East Cleveland estimates that one fourth of the vineyards in that section have been destroyed by this insect pest, and according to his observations the Wordens and Catawbas suffer more than the Concord. The most serious damage in his experience was met with on the lighter soil of knolls.

Mr W. W. Dille of Nottingham is of the opinion that there has been a decrease in recent years of 40% in the area devoted to grapes. He attributes this shrinkage about equally to the rot, which has been very prevalent, to the operations of the grape root worm, and prevailing low prices. He states that the insect injuries have been limited mostly to the bluff and to vineyards in the near vicinity of the lake shore, those back and just under the bluff escaping with comparatively little damage. He considers the Concord as one of the most resistant varieties.

A number of other growers were interviewed and some disparity of opinion naturally prevailed. It will be seen, however, that there are a number of well informed men in that section who attribute very serious injuries to this insect, and while the estimates of some may be excessive, there can be no doubt but that the pest has caused very serious losses. The season of 1902 was unfavorable for observing the work of this pest because the repeated rains have enabled the vines to sustain much greater injury than they would in times when there was less moisture. These conditions prevented the making of personal observations on the destructiveness of the insect and most of our data relating to this had to be obtained from the evidence of others.

Considerable attention was also given to the various remedial measures employed by different growers and some diversity of opinion existed. A number had sprayed their vines with arsenate of lead and also with bordeaux mixture. A few were of the opinion that spraying with arsenate of lead is a very efficient check on the increase of the insect, while others believe that it was of comparatively little value. Mr T. S. Clymonts states that spraying with the bordeaux mixture alone affords

some protection, as the beetles migrate to untreated vines. This subject will be discussed more at length under "Remedial measures." Most of the growers agree that thorough cultivation assists the vines greatly in resisting the depredations of the grubs. The parties on whose premises carbon bisulfid was used were not favorably impressed with the substance. They state that in any event the cost of application is excessive considering the prevailing low prices for grapes. Considerable injury was also inflicted on certain vineyards and it is very doubtful if this measure can be used to advantage.

Early history. This insect was first brought to notice in 1866 when specimens were sent from Kentucky to Mr B. D. Walsh, afterward state entomologist of Illinois. This gentleman stated at the time that he had taken the beetle in small numbers in both north and south Illinois, and later in the same year described the species. He also received the insect the following year from St Louis and Bluffton Mo., where the adults were said to be eating both foliage and fruit. Prof. C. V. Riley, in his first report on the *Injurious and Beneficial Insects of Missouri*, characterizes this species as one of the worst foes to the grapevine in Missouri. This condemnation was based solely on the operations of the beetle on the leaves, an injury which is now regarded as of little importance compared with the work on the roots. Professor Riley received specimens from Bunker Hill Ill., in 1870, and in 1873 Mr G. R. Crotch described the insect under the name of Fidia murina and gave its recorded distribution as from the Middle and Southern states. The identity of the species described by Mr Crotch and this insect was pointed out by Dr Horn in 1892, when he recorded its distribution as from the "Middle States to Dakota, Florida and Texas." He also states that the insect described by Lefevre under the name of Fidia lurida belongs to this species. This pest was received from the vicinity of Iowa City Io., by Prof. H. F. Wickham in 1888, and Professor Riley has recorded this form and the allied F. longipes Melsh. as injuring grape leaves at Vineland Ark.

Nothing further was known regarding this species till 1893 when specimens were sent to Prof. F. M. Webster, then of the Ohio Agricultural Experiment Station, who made an exhaustive study of the insect and published a detailed account of his investigations in 1895.

Injuries by this insect in the state of Arkansas were recorded by Prof. J. T. Stinson in 1896, and in the same year Professor Webster notes a decrease in the numbers of the pest in Ohio vineyards and attributes it as possibly due to the efficient work of two egg parasites and a mite, Heteropus ventricosus Newport. The following year Messrs Webster and Mally reported, as a result of a series of experiments, that tobacco dust and kainit were practically ineffective against this insect, and two years later these gentlemen record the unusual abundance of the pest in Ohio vineyards, and state that serious injuries occurred at Bloomington Ill. The presence of this beetle in destructive numbers in the Chautauqua grape belt was recorded by Prof. M. V. Slingerland in 1900, who at that time published a general compiled account of the insect. Dr J. B. Smith in his *Catalog of the Insects of New Jersey* states that this species occurs throughout New Jersey on the grape and Ampelopsis, and he also records it from Staten island. A brief note published by Dr L. O. Howard last year states that the depredations of this insect at Bloomington Ill. continue unabated and severe damage to vineyards is recorded. The writer, in the early spring, published a brief notice of the extent of the injuries in the Chautauqua grape belt with a summary of the life history of the pest and outlined a series of experiments, which latter are reported on in detail in this bulletin.

DESCRIPTION

The perfect insect is a small, brown, rather robust beetle about ¼ inch in length and rather densely covered with short grayish white hairs. It may be recognized by aid of plate 1, figure 1.

The egg is about $\frac{1}{25}$ inch in length and with its transverse diameter about one fourth as great. Form, nearly cylindric,

tapering a trifle at each end. The shell is flexible and when a number of eggs are crowded in a small space their form may become somewhat distorted. The eggs are white when first deposited, but soon assume a yellowish cast. On the fourth day a narrow semitransparent band appears near each end. The eggs of the clusters have a somewhat concentric arrangement and they range in number from 1 to 125. Several clusters are represented on plate 1, figure 4.

The young larva is subcylindric, about $\frac{1}{17}$ inch in length and tapers somewhat posteriorly. The head is a pale, yellowish color with the mouth parts ranging from light to dark brown, the sutures and tips of the mandibles having the most color. The head is somewhat flattened, bilobed and with the posterior angles rounded. The mandibles are distinctly toothed. The body is slightly smaller than the head, convoluted and distinctly segmented. Each segment bears a transverse row of small tubercles, from each of which a long hair arises. The spiracles, or breathing pores, are darker than the body and usually light yellow.

The nearly full grown grub resembles the newly hatched individuals very much in general form and color. It is then about $\frac{3}{8}$ inch in length, with a yellowish brown head and the mouth parts and adjacent sutures dark brown or nearly black. The body has a greater transverse diameter than the head, is distinctly segmented and bears numerous irregular transverse rows of small setae, which are relatively much shorter than in recently hatched individuals. The spiracles are well marked and range in color from yellowish brown to light brown. The general appearance of the grub is shown on plate 1, figure 4.

The pupa ranges in length from about $\frac{1}{4}$ to $\frac{1}{3}$ inch and its general features are represented on plate 1, figure 6. Its characteristics have been minutely described by Professor Webster as follows: "Color, white with pinkish tinge about head, thorax and posterior extremity; head with a semicircular row of four spines, the frontal pair erect, the other two smaller and divergent; near anterior margin of thorax there is a similar row,

likewise placed in the form of a semicircle, while just behind these is a cluster of four smaller and more erect bristles placed in pairs, the anterior of these being the most widely separated. Anterior femora armed at tip with a short, hooked spine, while above and at one side is a single, straight spine terminating in a bristle, posterior femora armed with a stouter hook and two stouter, erect spinular bristles, middle femora unarmed; at posterior extremity are two stout, flattened hooks, whose points extend upward; on the dorsum of the penultimate segment is a row of four distantly placed decumbent spines while on the preceding segment is a median, transverse, closely placed row of four, stout, erect spines, each of the other segments being provided with a single row of minute, short bristles, with two larger ones on the scutellum.

"In the majority of my specimens the anal hooks are as described . . . In some, however, they are bifid, one hook extending upward and the other downward, in which case the spines are much stouter, while beneath are two very short, stubby, hooked appendages. In one specimen one of the anal hooks is bifid and the other simple, and beneath the former is one of the short appendages while there are two of these, closely placed beneath the latter."

LIFE HISTORY

The life history of this insect may be summarized as follows:

The winter is passed by the nearly full grown grubs in oval cells in the soil and, so far as our observations go, the great majority of them occur from 10 to 12 inches below the surface and mostly near the subsoil. On the approach of warm weather, the grubs work upward, probably early in May in most years, and may then be found within a few inches of the surface and usually within 15 to 24 inches of the stem of the grapevine. The transformation to the pupa occurs in normal seasons from about June 1 to 20, the adults issuing approximately two weeks later or from about June 20 onward. The great majority of the beetles appear the last of June, though some

do not emerge till much later. A pupa was met with Aug. 15, 1902, and adults have been found in New York vineyards as late as early September. These latter are probably descendants of belated larvae. The eggs are normally laid from the last of June through July under the loose bark of last year's wood and require a period of about two weeks to hatch. The young grubs make little attempt to crawl down the stem and usually fall under the loose soil and make their way to the small feeding roots where under favorable conditions they grow rapidly and after increasing considerably in size, attack the larger roots, eating away long strips of the bark, plate 1, figure 5. The latter, when a large number of grubs are present, may rest simply on a bed of borings. Many of the grubs attain nearly full size the latter part of August or early in September. Late in the fall the larvae descend to considerable depths, as previously noted, construct their oval cells and pass the winter within them.

Habits of the beetle. The habits of the beetle are of special interest because it is possible to collect these insects and thus in a large measure prevent egg laying and consequent damage from the grubs. Professor Webster states that the beetles normally begin to appear in northern Ohio about June 20. This coincides rather closely with our own observations, because most growers agree in considering the season of 1902 remarkably late, and it is therefore not surprising that we met with very few beetles previous to July 2. Their first appearance was on light soil and the insects did not begin to emerge in numbers on heavy land till nearly a week later. The time of appearance and the fact that a large proportion of the insects seem to issue from the ground within a day or two is of much importance, if anything is to be done by collecting the insects. The beetles appear to emerge and remain on the foliage, particularly around buds, several days before they feed to any extent. Breeding cage experiments have fixed this period at from one to four days. Two beetles which actually emerged under observation refused food till the fourth day, and it is very probable

that this period is more nearly the normal time between the emergence of the beetles and feeding. A considerable number may be found before any feeding has taken place, as is evidenced by Mr Barden taking 12 from a vine which bore practically no marks of their eating. The insects may be found in a field over an extended period. Some were observed by Mr T. T. Neill Sep. 4, 1902, in a vineyard at Fredonia.

Oviposition does not occur till some days after the appearance of the perfect insects and according to breeding cage observations this period may range from 10 to 17 days. Our breeding cage experiments also indicate that the insect may feed from 6 to 13 days before eggs are deposited. This period was carefully ascertained by isolating a series of males and females and providing them with as nearly natural conditions as possible. Both of these periods are much longer than normal, since eggs were found by Mr Barden in the Northrop vineyard July 9, where beetles were present in very small numbers on the second. This allows a maximum of only seven days between the appearance of the earliest insects and the deposition of eggs, and, if, as can hardly be questioned, the insects remain without taking food for two or three days, then the time of feeding before the deposition of eggs can hardly exceed an equal period. This matter is of considerable importance because it shows how quickly poisons must act in order to prevent the deposition of any eggs.

The feeding of the beetles occurs almost entirely on the upper surface of the leaves and, as described by Professor Webster, "is done by gathering a quantity of the substance of the leaf in the mandibles and jerking the head upwards, after which the body is moved a step forward and another mouthful of food secured as before. After securing a few mouthfuls in this way they move to another place and begin again, thus eating out numerous chainlike rows of silk net as shown on plates 5 and 1, figure 2. The insects eat only to the lower epidermis on foliage having a velvety under surface, but on others they eat entirely through the leaf." The individuals feeding on the leaves are

easily frightened, and when alarmed usually fold up their legs and fall to the ground, where they remain quiet till all danger appears to have passed. The beetles on the wood, however, are not so easily disturbed. They can frequently be picked from the vine, and it requires repeated jarring to dislodge all. This is of considerable importance when collecting beetles with any machine and the persistence with which some hang to the wood offers a serious obstacle to this method of controlling the insect.

The tendency of this species to remain in a locality is well shown in a certain vineyard at Ripley. It had suffered very severely in earlier years from the depredations of this pest and a portion of it was uprooted last spring. A small area was allowed to remain in the hope that it could be brought back to a normal condition. A few rows next to the uprooted area were fed on to a very great extent by the beetles, which had evidently emerged from the adjacent soil and made their way to the nearest vines where they were content to remain and feed. The extensive injury inflicted on these vines is well illustrated on plate 4, which shows how badly many of the leaves were riddled. A curious fact in connection with the abundance of the beetles on these small vines is that few or no eggs could be found and there is apparently no reason for such a condition. This tendency of the insects to remain in one locality is very favorable to growers attempting to control the pest, as there is less danger of their flying from infested vineyards where no effort is made to check them.

Eggs. The eggs of this insect are deposited almost entirely under the loose bark of last year's wood, many being found as high as the top wire. Professor Webster states that over 700 have been taken from a single vine, and from a section 16 inches in length and an inch in diameter he took 225 eggs. Once he found a few eggs pushed down between the earth and the base of the vine, but we have failed to find eggs in any such position. Beetles in confinement deposited eggs in crevices and cavities of the wood and even on leaves. Eggs were found in the field in 1902 as early as July 9 and oviposition was

still in progress Aug. 15, and though beetles were less abundant than three weeks before, it was still easy to find individuals which contained fully developed eggs. Careful breeding cage experiments were planned to determine the duration of the period of oviposition, the time when the eggs were laid and the total number deposited by a female. A number of pairs of beetles were isolated and provided daily with fresh food. The period of oviposition for a number of confined females was found to extend over a period of 40 days, and in the case of individuals from 7 to 13 days. The records of a few beetles, showing the number of eggs and the size of the clusters in which they were deposited and found, are given herewith.

BEETLE NO. 1

July 11, clusters of 75, 16, 29 and 14 eggs
July 12, a cluster of 33 eggs
July 15, " 20 "
Total, 187 eggs

Some of the clusters recorded for July 11 had been deposited on earlier dates and escaped detection, since they showed the characteristic band near each end, which does not appear for four days.

BEETLE NO. 2

July 13, a cluster of 20 eggs
July 18, " 5 "
July 20, " 25 "
July 21, " 36 "
July 25, " 25 "
July 29, " 30 "
Total, 141 eggs

BEETLE NO. 3

July 11, a cluster of 70 eggs (possibly older than date given)
July 13, " 36 "
Total, 106 eggs

It may be seen by the above records that the beetles deposit clusters of considerable size at intervals of one to three or more

days. The insects which made these records were confined in jelly tumblers, with a small piece of cane and fresh leaves supplied daily. A large number of beetles were also confined in one breeding jar and fed in the same way as the isolated pairs. A careful record of all eggs taken from this large breeding jar was kept and the approximate average for each female was 109. This latter indicates a strong probability of the beetles producing many more eggs under natural conditions. It is manifest that the above were not ideal conditions, and we know that individual adults have an extended existence, some in our breeding cages living and depositing eggs over most of the period from July 3 to Aug. 19. This, in connection with others being taken in vineyards as late as Sep. 5, renders it very probable that females in the field deposit as many eggs, if not a great many more.

Our observations on eggs laid in breeding jars showed that they are deposited in masses of from 1 to 125, the latter being the largest number observed in one cluster. A normal egg mass measures about $\frac{1}{5}$ inch in length and less than one half that in breadth. The somewhat concentric arrangement of the eggs is shown on plate 1, figure 3. The rows of eggs often overlap each other like shingles, and in the center of the mass there is frequently an appearance of two or three layers. The egg clusters are sometimes deposited so that two thirds of the branch is encircled, and in each case the whole mass is covered with a sticky substance, which glues each egg to the other in such a manner that the whole may be easily detached from the vine, as is often the case when a strong wind is blowing.

The duration of the egg stage was determined by repeated observations as from 9 to 12 days (it is stated to be eight days by Professor Webster), about one day being required for an entire mass of eggs to develop after hatching commenced. We were also able to verify Professor Webster's observation on the appearance of a narrow semitransparent band or line near each end of the eggs four days after oviposition. Small numbers of empty egg shells, indicating that hatching had begun, were

found in Mr G. L. Hough's vineyard July 24 and it is very probable that in Mr Clyde Dean's vineyard at Portland, where conditions are about a week earlier, young grubs had appeared some time before.

Habits of the larvae. The young larvae after they hatch from the eggs drop to the ground, as observed by Professor Webster and corroborated in our own experience. There seems to be very little or no attempt on the part of these tiny creatures to crawl down the stalk. A recently hatched grub is such a small creature that it rapidly makes its way into any crevice or crack, and when it drops on loose earth soon disappears from sight. Earlier writers have recommended the covering of the roots of grapevines as deeply practicable at the time the young hatch, so as to present more obstacles to the grubs when making their way to the roots. This suggested to the writer some experiments to determine the burrowing and traveling powers of these little creatures. One small grub was placed on a piece of paper at 9.27 in the morning and its wanderings carefully traced with a pencil till 4.43 in the afternoon. The little creature traveled almost continuously during that entire period and showed a decided tendency to turn to the left. It covered the relatively enormous distance of over 47 feet in seven hours, or an average of about 2 yards an hour. The grub was placed in a dry vial, and under such unfavorable conditions lived about three days. This would seem to indicate that the little creatures can make their way over many obstacles if not confronted by very unfavorable conditions.

Some tests were also planned to ascertain the burrowing powers of these little grubs. A glass tube 17 inches long and $\frac{1}{2}$ inch in diameter was bent so that 4 inches were vertical. It was then filled with loosely packed earth, and on July 29, 40 recently hatched grubs were placed on the surface of the soil in the 4 inch vertical portion. One grub had made its way through the entire mass of soil by July 31, another by Aug. 1, and 11 others by the third, making a total of 14 which had traveled the whole length of this tube in a period of four days.

Another ½ inch tube, 10 inches long with 3½ inches vertical and 6½ inches of its length horizontal was similarly packed and 13 grubs placed on the surface of the soil July 29. Four of these had made their way throughout the entire length of the tube by Aug. 3. Another tube 12 inches long, ½ inch in diameter, with 2½ inches of its length vertical and the remainder horizontal was filled with tightly packed soil and a number of grubs placed in it Aug. 1. On the 7th one grub had made its way through 7½ inches of this tightly packed material. It would seem from the above experiments that while a great many grubs undoubtedly perish in making their way from the vine to the succulent roots on which they feed, they are capable of overcoming great obstacles, and the facts ascertained above at least raise a question as to the advisability of attempting to interpose barriers between the grub and the roots on which it feeds.

The young larvae or grubs are undoubtedly able to exist for some time without food. They soon make their way when possible to the young feeding roots where they may sometimes be found in considerable numbers. The writer, the middle of last August, succeeded in finding eight of these little creatures under a small bunch of feeding roots. They were less than one quarter grown and under larger roots near them several others were found which were about half grown. The occurrence of few half grown larvae and of considerable numbers of nearly full grown individuals the middle of September indicates that these creatures develop very rapidly after they have found suitable roots on which to feed. The finding of a small grub scarcely $\frac{1}{16}$ inch long July 2 indicates that some do not attain their full growth in the fall, since this individual could not have hatched from an egg laid in 1902, as the beetles had hardly begun to appear, and that such individuals must feed to some extent in the spring. It seems probable that these very small grubs produce the beetles which emerge late in the summer, and are therefore responsible for the very extended period during which adults are found abroad. Most of the grubs complete or nearly complete their growth in the early fall, and on the

approach of cold weather descend deeper in the earth. Professor Webster records finding the grubs a foot below the surface in the spring, and our own observations indicate that they descend nearly to that depth where they pass the winter in small oval cells. Their ascent in the spring occurs after the appearance of warm weather and probably some time in early May.

Pupa. Professor Webster records the finding of a very few pupae as early as the first week in June, and Mr Barden states that in 1902 he observed the first pupae at Ripley June 7, though Mr Hough is of the opinion that the larvae began to transform as early as June 4. The great majority of the insects had transformed to this stage by June 23. The pupa cells are almost entirely within 2 or 3 inches of the surface and usually within 2 or 3 feet of the base of the vine.

The duration of the pupa stage has been stated by earlier writers as about a fortnight and actual observations with breeding cage material has enabled us to determine this period as from 13 to 14 days. These observations were made in the office, where temperature conditions were uniform and rather high, and it would not be surprising if this period was materially extended out doors by unusually cold weather.

The oval cells occupied by the larvae can be broken with impunity and the grubs will make others, but such is not true of the pupae. The insect is so delicate in the latter stage that the writer has experienced great difficulty in transmitting them through the mails, even with most careful packing. This is shown by the fact that out of 58 mailed to Albany only 15 arrived alive, a number were carefully packed in their cells or laid on moist cotton, otherwise the fatalities would have been much higher. These facts have a very important bearing on remedial measures, as will be pointed out under that head.

Food plants. This beetle has a comparatively restricted food habit. It was early observed by Mr Walsh on grapevines and the late Professor Riley recorded its feeding on the American redbud, *Cercis canadensis*. It is also known to feed

on the native Virginia creeper, Ampelopsis quinquefolia.

NATURAL ENEMIES

This serious grapevine pest is subject to attack by several natural enemies. Two interesting species of egg parasites, bearing the scientific names Fidiobia flavipes Ashm. and Brachysticha fidiae Ashm. were bred from eggs of this insect by Professor Webster in 1894 and in 1896 he expressed the belief that a marked decrease in numbers of the Fidia was possibly due to the work of these parasites. Professor Webster also observed a small brown ant, Lasius brunneus var. alienus feeding on the eggs, and a small mite, provisionally identified for Professor Webster by Dr George Marx, as Tyroglyphus phylloxerae P. and R., extracting the contents of several eggs in succession, and also a smaller mite resembling Hoplophora arctata Riley. One of these small mites, probably a species of Tyroglyphus, was observed in our breeding cages feeding on the pupae, one being almost entirely destroyed.

Several predaceous insects were found by us during field work, specially when digging for larvae in the early spring. The grubs of some carabid beetle were observed to be about two thirds as numerous as those of Fidia during the last of April and it is very probable that they prey on this species. We were unable to bring any of the carabids to maturity. A small beetle, Staphylinus vulpinus Nordm. was associated with Fidia grubs and possibly preys on them. The larva of an aphis lion, Chrysopa species, was observed by the writer investigating under loose bark where eggs were present, and it is not at all improbable that these insects destroy many.

REMEDIAL MEASURES

It was felt that there was a lack of of definite knowledge regarding methods of controlling this insect when this study was undertaken, and it was accordingly planned to make a thorough test of those advised as well as to experiment along

other lines. Some of these investigations gave results which appear to have a positive value, while others only proved certain measures comparatively useless.

Destroying the pupae. Our finding the pupae of this insect within three inches of the surface of the soil and their great delicacy led Mr Barden to suggest that a certain field be cultivated at a time when the majority of the insects were in the pupal stage. The earth was plowed away from the vines and then turned back, care being taken to get as close to the roots as possible. Investigations in this field in the early part of June resulting in finding from 50 to 60 grubs about many of the vines, while repeated search the latter part of the same month failed to uncover more than three or four insects about a vine and in many cases not a specimen was found. It was too early for the insects to emerge and destruction by cultivation appears to be the most reasonable if not the only way of accounting for their disappearance. This, taken in connection with the great care necessary in handling the pupae, leads us to believe that much can be accomplished by so planning cultural operations that the vineyards will be horse-hoed at the time when the majority of the insects are in the pupa or "turtle" stage. It has been shown on a preceding page that a difference of a week or more may exist in the development of the insect in vineyards within a few miles of each other, and this is probably true of localities even nearer each other. The insects being in the earth are affected by its character and in a warm, light soil emerge earlier than in a heavy one. This difference in the period when the beetles appear renders it necessary for each vineyardist to keep watch of the development of the insects on his own grounds, and plan to do his cultivating at the most favorable time. The pupal stage, as determined by careful experiments, lasts about two weeks, and as the emergence of the beetles extends over a considerable period, it is suggested that the cultivation be delayed till a few of the very early beetles are nearly ready to emerge from the soil. No very serious injury will result if a few actually forsake their pupal

chambers, though if many appear it is probable that the most advantageous time for this work has passed. Plan to plow or cultivate as close to the vines as possible when attempting to destroy the pupae and aim to make the earth fine. It is not necessary to go to a depth of more than 3 inches.

Collecting beetles. This method of controlling the grapevine root worm did not promise much when it was first attempted. Professor Webster had either not considered it worth trying or had found it of comparatively little value, and Dr Marlatt did not even mention it in his recommendations. Professor Slingerland makes the guarded statement that it may be practicable in some cases to jar the beetles into a collecting apparatus, but he apparently had little faith in the plan, except where the beetles could be jarred to the ground where they would be eaten by chickens.

Mr J. J. Barden, working under the writer's directions, found that even with a plain cloth-covered frame several feet square and with a small slit in one side, so that it could be slipped under a vine, that large numbers of the insects could be collected. With this crude apparatus he was able to capture a quart of beetles in about two hours. This indicated that much better results could be secured with a more elaborate apparatus, and with the aid of Mr G. L. Hough he constructed a modified form of the Curculio catcher, which is represented on plate 6. The machine is 6 feet long and 3 feet wide at the top with vertical ends and the sides sloping to a trough about 3 inches square. A central slit about 3 inches wide was cut in the side opposite the handles and the whole mounted on a two wheeled frame. The central trough is subdivided by a few transverse partitions and these spaces are partly filled with kerosene and water. The sides, ends and trough are constructed of galvanized iron and strengthened with iron straps as shown in the figure. The wheels are from a toy cart and the handles and frame are homemade. The method of operation is simply to wheel the machine between the vines and then, elevating the handles, the farther side can be slipped under the wire, and the trunk of the vine

entering the slit permits the placing of the machine directly under the vine. It then remains for the operator to jar the insects off. Mr Barden found that it required several shakings to dislodge all the beetles. In one case he succeeded in catching 64 by jarring a vine once. It was found advantageous to have three machines operating together and placed simultaneously under adjacent vines. This arrangement facilitated the work very greatly and reduced to a minimum the beetles jarred from vines before a machine could be placed under them.

This method appealed so strongly to Mr Hough, who by the way is a very practical business man, that he used it daily for a time on certain badly infested vines and found that in the case of those jarred twice, he did not get over three or four beetles to a vine, whereas at the first operation 40 to 50 were secured and 15 or 20 at the second jarring. An examination in this vineyard July 24 showed that the beetles were not nearly so abundant as two weeks before, probably largely due to the four collectings in the two weeks.

The principal difficulty with the present machine is the relatively large amount of time consumed in placing it under a vine and shaking it two or three times. It would seem possible to devise a practical machine which, while it might not collect as many beetles at any one operation, would catch a considerable number while being dragged, carried or pushed between the vines. This would prevent the delay incident to stopping at every vine, and permit so much more rapid work that a considerable sacrifice in the proportion of beetles captured would be permissible. It would probably require less than one quarter of the time to collect with such a machine, and it is hoped some mechanic will be ingenious enough to make some practical device. The period of about seven days existing between the appearance of the earliest beetles and oviposition would allow considerable collecting before any eggs were deposited.

The late Prof. C. V. Riley, in his report for 1868, calls attention to the fact that one man whose vineyards were very badly infested by this insect had trained his chickens to go between the vines and pick up the beetles as they were dislodged by

jarring. Mr F. A. Morehouse of Ripley, who has many chickens in the near vicinity of his vineyard, has practised the same thing with excellent results. The only trouble is that this method has a comparatively limited application, since it is not always practical to have chickens in large vineyards.

Arsenical poisons. A number of experiments were tried with arsenical poisons for the purpose of ascertaining their efficiency in controlling this species. Two brands of arsenate of lead and paris green were used. Breeding cage experiments with arsenate of lead, using 2 pounds to 50 gallons of water, showed that seven days were required to kill 9 out of 10 beetles, and that when 4 pounds of the poison were used to the same amount of water all of the insects were killed within eight days. The spraying in both instances occurred July 5 and the record is as follows:

2 POUNDS OF ARSENATE OF LEAD TO 50 GALLONS OF WATER

July 7, 6 beetles dead, 3 alive, 1 missing
July 10, another beetle dead
July 11 "
July 12 "

4 POUNDS ARSENATE OF LEAD TO 50 GALLONS OF WATER

July 7, 4 beetles dead
July 9, 4 more dead
July 10, another dead
July 13 "

It will be seen by examining the above records that in the case of the first over half were killed within 48 hours after the spraying, and in the second less than half within 48 hours and four fifths within four days. It should be added that in the above experiments the leaves were sprayed very thoroughly and the poison allowed to dry before the treated foliage was placed in the cage.

The breeding cage experiments with paris green were less successful than those with arsenate of lead, and though in one experiment 20% of the beetles were killed within 48 hours after

spraying the leaves with 1 pound of the poison and 1 pound of lime to 100 gallons of water, and 40% more died within four days after the spraying, the general results were not at all satisfactory and the reason therefor can not be given.

The breeding cage experiments with arsenate of lead would lead one to expect most excellent results in the field, but such was not the case in our own experience, though this may have been due to the fact that the spraying was done shortly before considerable rain fell, and was followed by nearly daily precipitations. The initial application was made July 8 and repeated July 9, the rain of the preceding day making it advisable to go over the entire field a second time. The ground at the time the spraying was done was so wet that it was almost impossible to drive a team slowly enough to do good work. Careful search in the vineyard eight days after failed to reveal a single dead beetle. July 31 there were plenty of beetles and many eggs in Mr Northrop's vineyard where the vines had been sprayed. The necessity of two sprayings resulted in the application of considerable poison, and about five weeks after the treatment it was seen that the sprayed vines had developed very little new growth as compared with untreated ones. There was no perceptible burning, yet the edges of the leaves were somewhat crumpled and it is very probable that the poison checked the development of the more tender shoots.

The evidence concerning the efficacy of poisons in Ohio, as pointed out on a preceding page, is somewhat contradictory. Reporting on work done in 1899, Professor Webster states that an examination of sprayed fields showed nothing to indicate that arsenate of lead would not prove entirely effective. This differs from some later experiments performed under his direction by Messrs Newell and Burgess the unpublished records of which, through the kindness of Prof. P. J. Parrott, have been placed at my disposal. The summary of this later work is as follows: "Where beetles were abundant last year and vines seemingly badly injured and the arsenate of lead or disparene used this year (1900) few vines have died and all appear

in a more healthy condition, but this is true also where none of these insecticides were used, beetles appearing later and in less numbers than for several years." Professor Webster, at the writer's request, has commented on the above experiments as follows. He states that early results though satisfactory were not thought by him to be conclusive and that a marked decrease in the number of the beetles, vitiated later experiments to some extent, so that he did not consider them as either conclusive in themselves or as disproving the earlier work of Mr Mally. He states that arsenate of lead must be tried thoroughly several times where conditions are such as to enable one to obtain decisive results either one way or the other before it will be safe to make definite statements. Professor Stinson reports only fair success in destroying the beetles with poisons in Arkansas.

It seems very probable, therefore, that some of the Ohio growers have been led to attribute the relative scarcity of these beetles to the use of poison whereas it may have been due almost entirely to natural conditions.

The beetles apparently ate the poisoned foliage almost as readily as the unpoisoned in our breeding cages, and nearly the same results are reported by Professor Mally. They are voracious eaters and it would therefore seem as though they would be amenable to this treatment, provided the insecticide is on the vines at the time the beetles appear. Even if they are not killed in the first three or four days, our studies of the egg-laying habits show that if the adults are not destroyed for a week or more, they would be prevented from depositing a large proportion of their normal quota of eggs.

The evidence at hand is altogether too little to warrant the statement that poisons are of little value against this insect, but it seems probable that these substances will be found efficacious only when they are applied most thoroughly and under favorable conditions. We can not under present conditions feel the confidence of some earlier writers in poison sprays for this insect.

Mr T. S. Clymonts states that in his experience spraying with bordeaux mixture has proved of some benefit, since the beetles

prefer untreated vines and will migrate to them if nearby. It may be that this very efficient fungicide could be used with even greater benefit if a moderate amount of arsenate of lead were added to it. This combined insecticide and fungicide we hope to test another season.

Pulverizing the soil and mounding. Prof. F. M. Webster, as a result of his studies, advised thorough cultivation of the soil during the hatching period, taking special pains to keep it banked up over the roots. Professor Webster's idea was that the young insects dropping in the dry sand would be quickly destroyed wherever exposed to the sun, that the looseness of the surface layers would prove a serious hindrance to their burrowing, and that the increased depth over the roots would also provide an additional barrier to the grubs. Thorough cultivation is undoubtedly a most excellent thing and the additional vigor arising therefrom is a valuable asset in enabling the vine to withstand very serious injury. Our experiments on the traveling and burrowing powers of these little grubs, however, lead us to believe that this measure, so far as preventing access to the roots is concerned, is not of much value. This is confirmed somewhat by the experience of Mr T. S. Clymonts, who states that a seriously injured vineyard can be renewed by thorough cultivation, and that he has experienced no difficulty in doing this with flat cultivation. In fact Mr Clymonts is of the opinion that mounding the earth about the vines is injurious in other ways and therefore does not advise it. He recommends cutting back the vines to the living wood, enriching the land liberally with stable manure and applying about a barrel of salt to the acre. Then he cultivates with a disk harrow or other tool which will not stir the earth to a great depth, since he believes that deep plowing cuts off a large number of roots and is very injurious to the vines. He states that in several cases known to him where this has been done and flat culture adhered to, badly damaged vineyards have been restored to a very satisfactory condition.

Carbon bisulfid. Prof. F. M. Webster instituted some rather

extensive experiments with carbon bisulfid against this insect and the summary of his results are as follows. He found that the substance could not be used to advantage in soil that was very dry or saturated with water, and that it must be used in that which is damp. He states that the most satisfactory results will probably follow its use in the spring, in a damp soil, when it is applied in such a manner as to fumigate the roots without the fluid coming in contact with them. He recommends from 4 to 6 ounces for each vine and states that it is not possible to kill every worm about each vine, and that it is doubtful if the low price then current for fruit would justify its use. Growers in the vicinity of Cleveland have not used this insecticide to any extent since the time Professor Webster made his experiments, and they give the high cost as the reason for its not being adopted. It should also be added that considerable care is necessary or the vines will be severely injured.

Kerosene emulsion. Several writers have advised killing the grubs at the base of the vines by the use of a kerosene emulsion, which is to be washed to a greater depth by copious watering or subsequent rain. We have seen very few cases where the grubs were congregated sufficiently to warrant any attempt at killing them in this manner and it hardly appears practical in a large vineyard.

Crude petroleum. It was hoped that it would be possible to destroy the grubs of this pest by the application of this substance to the soil, and there seemed a chance of using it to prevent the young larvæ making their way to the roots. Some experiments in the office, however, demonstrated that the grubs easily penetrated soil which had the surface layers moistened by a fine spray of the oil, specially if placed on the soil 30 minutes to half a day or more after treatment. This substance appears to have very little value in controlling this insect.

Effect of calcium carbid refuse on grubs. Our attention was called to this substance by the statement that it had proved very valuable against the Phylloxera in France. Some of the material was kindly sent us from the Union Carbide Company's

plant at Niagara Falls and various experiments with the grubs were tried. One part of this substance mixed with 10 pounds of soil was placed in a box and some grubs added. One was dead the next day after having burrowed about ¼ inch and two others went to the depth respectively of 1¼ and 2 inches. No additional fatalities occurred even after 10 days. Several other experiments gave the same general results and apparently we can have no hopes of this substance being of value in this particular case.

Recommendations. Apparently no one method can be relied on to control this insect and our recommendations may be summarized as follows: Plan cultural operations so that horse hoeing from the vines or other cultivation will occur when the great majority of the insects are in the pupal stage and take special pains to thoroughly disturb the soil in the near vicinity of the stem. Thorough cultivation and well enriched soil will do much in aiding the vines to withstand attack. This, supplemented by collecting beetles, particularly if a device can be made which will catch them without the delay incident to stopping at each vine, is advisable on badly infested areas during the first week or 10 days after the adult insects appear. The latter may be supplemented or replaced by thorough spraying with an arsenical poison, preferably arsenate of lead, when the beetles begin to appear. Evidence at hand is rather condemnatory of spraying in the field, but laboratory results indicate that it should be thoroughly successful, and later experiments may demonstrate this to be the case.

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1902 Felt, E. P. Country Gentleman, May 15, 67:413. (Brief general account with outlines of proposed experiments); —— July 10, p.574–75. (Pupae readily destroyed by cultivation); State Entomologist. 17th Rep't 1901, 1902, p.733–34, fig. 8 (established about Ripley, collected about Albany in 1880), p.837 (partial bibliography); same in East. N. Y. Hortic. Rep't. 6th Ann. Meeting 1902, p.215–16; U. S. Dep't Agric. Div. Ent. Bul. 37 n. s. p.102–3. (Injuries in Chautauqua grape belt).

L. H. Joutel, 1902

Grapevine root worm

Photo Aug. 15, 1902

Vineyard badly injured by grapevine root worm (The vines should cover the wires and posts.)

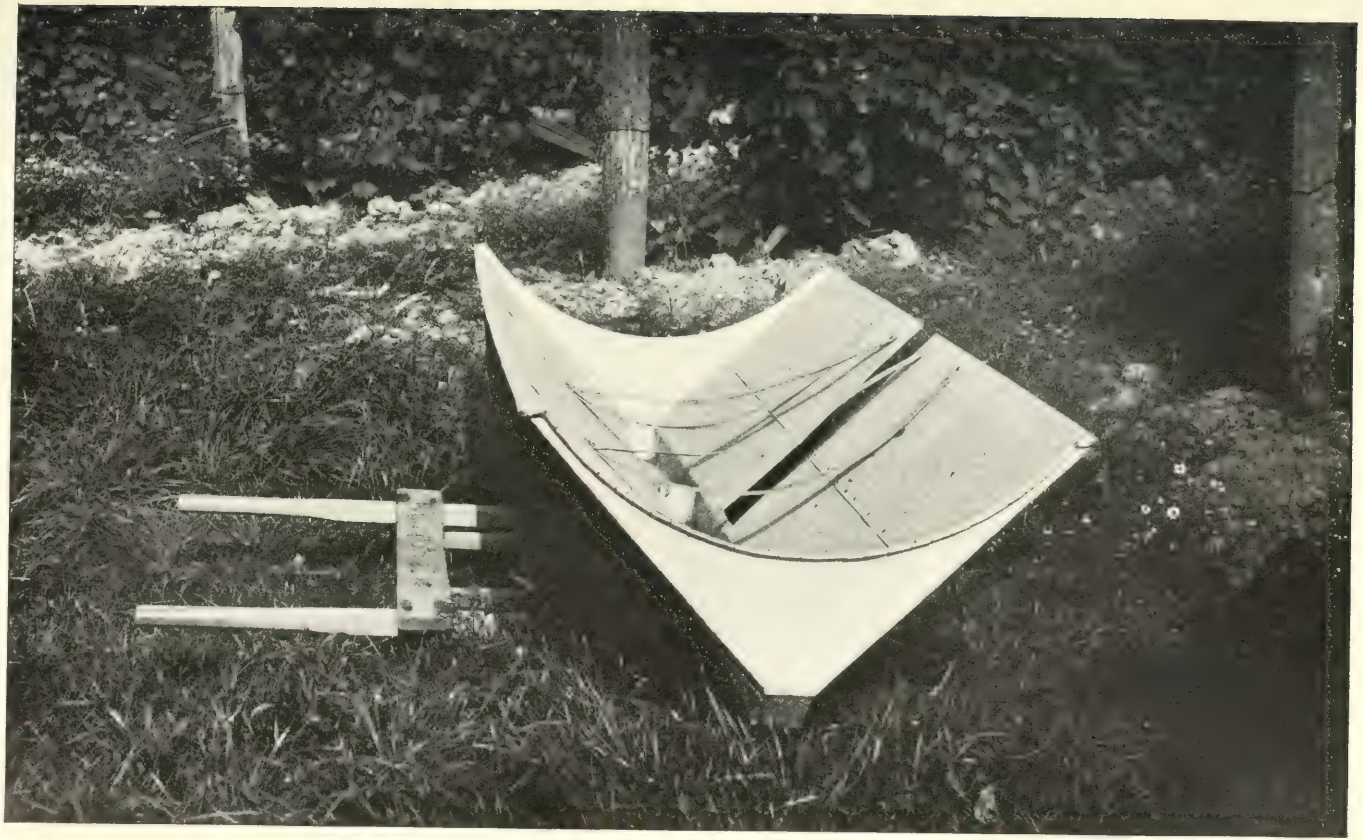
Photo Aug. 15, 1902

Vineyard very badly injured by grapevine root worm (Most of this piece was torn out by the owner as worthless.)

Photo Aug. 15, 1902

Foliage badly eaten by beetles

Leaves from badly eaten vine, illustrating the peculiar chainlike eroded areas



Beetle catcher

Photo Aug. 15, 1902

EXPLANATION OF PLATES

Plate 1[1]

Fig.

1 Beetle, much enlarged

2 Leaf badly riddled by the beetle

3 Eggs on last year's wood, the loose bark has been lifted so as to expose them.

4 Larva or grub, much enlarged

5 Work of larva or grub on larger roots

6 Pupa or "turtle stage" in cell

7 Same much enlarged

Plate 2

Vineyard badly injured by the grapevine root worm. Observe that very few of the vines extend to the top wire. The wires and posts would ordinarily be concealed in a thrifty vineyard.

Plate 3

Vineyard more seriously infested than the preceding. A portion of this was uprooted last spring, and the area shown was kept simply for experimental purposes.

Plate 4

Portion of two vines represented on the preceding plate and showing how badly the beetles may eat the foliage when abundant.

Plate 5

Leaves from badly eaten vine, illustrating the peculiar, chain-like eaten areas.

Plate 6

Beetle catcher devised by Messrs Hough and Barden.

[1] Executed from nature under the author's direction by L. H. Joutel.

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New York State Museum

FREDERICK J. H. MERRILL Director
EPHRAIM PORTER FELT State Entomologist

Bulletin 64

ENTOMOLOGY 17

18th Report of the State Entomologist

ON

INJURIOUS AND OTHER INSECTS

OF THE

STATE OF NEW YORK

1902

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University of the State of New York

New York State Museum

FREDERICK J. H. MERRILL Director
EPHRAIM PORTER FELT State Entomologist

Bulletin 64

ENTOMOLOGY 17

18th REPORT OF THE STATE ENTOMOLOGIST

1902

To the Regents of the University of the State of New York

I have the honor of presenting herewith my report on the injurious and other insects in the State of New York for the year ending Oct. 15, 1902.

General entomologic features. The season of 1902 was comparatively poor for the development of many insects, and as a consequence relatively few species destructive to staple crops were brought to notice. The elm leaf beetle, Galerucella luteola Müll., has continued its ravages in the Hudson river valley, is gradually extending its range, and is worthy of particular mention because of its having become established in force at Schenectady and Saratoga Springs. The white marked tussock moth, Notolophus leucostigma Abb. & Sm., is a well known pest of city shade trees, and serious depredations by it have been recorded from time to time. Thousands of horse chestnuts in the vicinity of Buffalo were practically defoliated by this insect during the past season, and it is not improbable that the same would have been true of other cities in the western part of the State had it not been for persistent efforts to check the insect in earlier years. The fall webworm, Hyphantria textor Harris, is a common pest which is generally destructive to many trees. It was unusually abundant and injurious in the southern part of the State, particularly in Orange county, and also to a lesser extent in some of the western counties. The black banded Lecanium, Lecanium nigrofasciatum

Perg., is an insect which has attracted comparatively little attention in this State. It was noticed briefly in our preceding report, and during the past summer has become unusually abundant on many soft maples in the city of Albany. The birch leaf Bucculatrix, Bucculatrix canadensisella Chamb., was extremely abundant and injurious over an extended area in 1901 and during the present year has been almost as destructive in portions of the same area. The operations of several bark borers were brought to notice in 1901, and it is gratifying to state that the injuries by these destructive little creatures appear to be lessening. An interesting insect bearing the common name of the carrot rust fly, Psila rosae Linn., was brought to our attention last December on account of its operations in celery at Broadalbin, Fulton co. This is believed to be the first instance of the insect being known to occur in the State.

Office work. It is very gratifying to note that the interest in the work of the office and the demands made on its staff have steadily increased. The determination of scale insects for the commissioner of agriculture, in connection with the nursery inspection work of his department, makes considerable inroads on our time. Most of this delicate and important work has devolved on the first assistant, Mr C. M. Walker. Many photographs of living insects or specimens of their work have been taken during the course of the year, and a number of lantern slides have been added to our collection, which has already been used to excellent advantage in illustrating popular lectures. The mailing list of the office has been largely increased during the past year, principally by paid subscriptions, showing that the public desires our publications and is willing to pay for them when the method of obtaining them is known. The correspondence has nearly doubled over that of the preceding year, as is evidenced by the following figures: 1559 letters, 1811 postals, 1842 circular letters and 2369 packages were sent through the mail during the past year.

The resignation of the first assistant, Miss M. F. Boynton, made a vacancy to which Mr C. M. Walker, then second assistant, was promoted. Mr Douglas B. Young, of Ilion, having successfully passed the civil service examination, was appointed second assistant. These changes in the office force can not be made

without interrupting the continuity of the work and in a measure marring its value. It is to be hoped that in time the salaries for assistants may be large enough to induce men to remain for a series of years.

Special investigations. The lines of work prosecuted in 1900 and 1901 have been continued and other investigations taken up.

The grapevine root worm, Fidia viticida Walsh, had caused so much injury in the Chautauqua grape belt that a special investigation of the pest was undertaken last spring and is still in progress.

The series of experiments with insecticides for the control of the San José scale have been carried on in the same orchard as during the last two years, and the earlier results have been largely confirmed. These have also been tested by experiments in other sections of the State. Further details of this work will be found on subsequent pages. A Chinese ladybug, Chilocorus similis Rossi, has been established in our experimental orchard in the hopes that it will prove a valuable ally in controlling this pest.

The study of forest and shade tree insects has been continued; and the observations of earlier years, together with those of the past season, are now ready for publication, and will appear in an extensive memoir.

The investigations on aquatic insects, commenced in 1900 by Dr J. G. Needham at Saranac Inn, and continued last year at Ithaca, were further prosecuted during the past season. The work of 1902 has been confined largely to a study of the stone flies, Perlidae, and a family of small flies, Chironomidae, a group which is very important so far as fish food is concerned, and which was also reported on to some extent by Mr O. A. Johannsen in Dr Needham's second report.

The entomologist has undertaken an investigation of mosquitos of the State, and considerable information has already been secured. Lack of funds and pressing duties have prevented bringing the work to a successful conclusion.

Publications. The principal publications of the entomologist, to the number of 64, are listed under the usual head. The more important of those issued during the past year are the following: *Scale Insects of Importance and a List of Species in New York*

State (Museum bulletin 46), *Aquatic Insects of the Adirondacks* (Museum bulletin 47), *17th Report of the State Entomologist* (Museum bulletin 53), and the *Elm leaf Beetle in New York State* (Museum bulletin 57). The former two, as stated in our previous report, were practically completed at the end of last year. The bulletin on the elm leaf beetle is an extended and revised edition of Museum bulletin 20, and was issued on account of the great demand for information concerning this serious pest of our elms. In addition to the above, the entomologist contributed an important paper on *Aquatic Insects of the Saranac Region* in the sixth annual report of the Forest, Fish and Game Commission, and one on shade tree pests for the report of the Colorado State Board of Horticulture for 1901.

Other important publications which are either in the printer's hands or practically completed are as follows: *Aquatic Insects in New York State*, which is a second report by Dr Needham and his associates, and treats largely of the damsel flies, Odonata-Zygoptera, the insect food of the brook trout, certain aquatic beetles (Donacia), some midges (Chironomidae), a group of much importance as food for fishes, and the Neuropterus family, Sialidae; the bulletin on the grapevine root worm, comprising a detailed account of this very injurious species, with special reference to its control, a publication of 36 pages; a monograph of the genus Saperda, which includes some of our most destructive wood borers, has been prepared by the entomologist in association with Mr L. H. Joutel of New York, and will form a small bulletin of about 40 pages, illustrated by seven colored plates; and the memoir on insects injurious to forest and shade trees, an extensive publication illustrated by many half tone and 16 colored plates, treating specially of those forms which are destructive to shade trees.

Collections of insects. Large additions to the State collections have been made during the past season. The systematic collecting at Karner begun last year was continued throughout the present season, and many interesting forms infesting various forest trees were secured. My second assistant, Mr D. B. Young, spent 10 days collecting at Newport N. Y., where the fauna is exceptionally rich, but, owing to continued unfavorable weather, the results were not all that were expected. Considerable pro-

gress has been made in arranging the Lepidoptera, the work of Mr Walker; while Mr Young has given much attention to the Coleoptera, and this order will soon be in a very satisfactory condition. The collection prepared for exhibition at the Pan-American Exposition has been installed in the museum and is now accessible to the public. A number of additions have been made to it, and desirable specimens are being added as fast as secured. A special collection, illustrating the characteristics of some of our more important mosquitos, has been put on exhibition.

New quarters. The past year is the first entire one in the present quarters; and the additional facilities afforded by them have proved of greatest value and permitted the undertaking of work which would have been impossible under earlier conditions. It was thought at the time the present quarters were assigned that there was ample space, but insects and examples of their work have accumulated so rapidly that a crowded condition is already beginning to prevail.

Voluntary observers. The work of the voluntary observers begun in 1899 has been continued, but, owing to the unusually cold, rainy season, there has been comparatively little to report. The observations made are published under the usual head [*see* p. 144].

Acknowledgments. The entomologist is under deep obligations to a number of professional workers. To Dr L. O. Howard, chief of the division of entomology of the United States Department of Agriculture, and his staff, special acknowledgments are due for the determination of a number of insects and for information supplied. Professor J. H. Comstock of Cornell University has kindly aided in prosecuting the work on aquatic insects during the past summer, and our thanks are due him for these services. It is a pleasure to acknowledge the continued support of the office by its many friends and to feel that our efforts have been so highly appreciated by those in authority.

Respectfully submitted

EPHRAIM PORTER FELT
State Entomologist

Office of the State Entomologist
Albany, Oct. 15, 1902

INJURIOUS INSECTS

Euproctis chrysorrhoea Linn.

BROWN TAIL MOTH

Ord. *Lepidoptera:* Fam. *Bombycidae*

Introduced or foreign insects have played a very important part in earlier years, and, if we may judge from recent developments, this leading role will be continued for some time. Our report for the year 1900 contains a summary notice of one of the most injurious foreign insects which have become established on our shores in recent years; and this occasion is taken advantage of to notice in a similar manner a more recently established species, which promises to be of considerable economic importance as a destroyer of fruit trees and also as a most serious annoyance to man in all localities where it becomes established in numbers. It is not often that an insect is destructive to vegetation and also markedly injurious to man, and yet this is true of the above named species. The hairs of the caterpillar of this species, coming in contact with the human flesh, produce "a fierce and enduring irritation," as characterized by Mr A. H. Kirkland; and so annoying and prevalent was this that the board of health of the city of Boston gave a public hearing on the subject in 1901.

Not in New York. This species does not occur in the State of New York; but, as both the male and female moths are provided with serviceable wings, and as they are readily carried by the winds and with household goods and probably other merchandise, it would not be surprising if the species became established in some locality in New York State in the near future. It was originally located at Somerville Mass., and in 1901 was known to have made its way nearly 30 miles west to Hudson Mass. This species, like some others, is readily controlled when present in small numbers; and, for this reason, we have deemed it advisable to illustrate the insect in color in its various stages, so that it may be readily recognized and promptly checked in any locality where it may obtain a foothold.

Distribution. Messrs Fernald and Kirkland state that the brown tail moth occurs in all parts of Europe, except the extreme north, and also in northwestern Africa and in Asia Minor.

Its presence in this country was first brought to the attention of Prof. C. H. Fernald in 1897, when it was learned that the species had become established in numbers in Cambridge and Somerville. During that year it was found that the pest occurred over the greater part of these two towns and Everett, in a small part of Medford near the Somerville line, and that there was a single colony in Malden. The following year a gale of wind occurred during the height of the flying season, and the moths were carried for a distance of 10 or 12 miles to the north and northeast, as stated by Professor Fernald. The rapidity with which the insect has extended its range is well illustrated by a table of the estimated area infested by the moth in the early years. This was prepared by Mr Kirkland and is as follows:

Area infested fall of	Square miles
1896	29
1897	158
1898	448
1899	928

It will be seen by the above that the insect is rapidly extending its range, and it is now known to occur at Kittery Me. and at Seabrook N. H.

Description. The male moths have a wing spread of about 1¼ inches, are pure white with a satiny luster on the fore wings and have a conspicuous reddish brown tuft at the tip of the abdomen [pl. 1, fig. 5, 6]. Sometimes there are a few black spots on the fore wings. The antennae are white and fringed with pale yellowish hairs.

The females have a wing spread of about 1¾ inches, are the same color as the males, except that they have no black spots on the wings, and the anal tuft is larger and lighter in color, while the antennae are shorter and with shorter fringes.

The eggs are laid in July in masses composed of 200 to 300 and placed usually on the underside of the leaves [pl. 1, fig. 1], where they are covered with brown hairs from the tip of the abdomen. They hatch in a short time, and the young feed during the rest of the season on the surface of the leaves, a few days only being required to skeletonize them. The caterpillars begin to make a nest in which they hibernate while still young. It is constructed on the twigs and is made by drawing together a few

leaves, lining them with silk, and inclosing them with a mass of silken threads. These tents [pl. 1, fig. 7] are so firmly secured to the twigs that they can not be removed without considerable force.

The young caterpillars emerge from their winter retreats before the leaves begin to appear, often attack swelling buds and complete their growth in the early part of June, when they transform to pupae. The full grown caterpillars [pl. 1, fig. 3] range from 1 inch to 1¼ inches in length. The pale brown head is mottled with dark brown and has reddish brown hairs scattered over its surface. The body is dark brown or black with numerous fine, dull orange or gray spots over the surface, which are most pronounced on the second, third and fourth segments. Long reddish brown, finely barbed hairs arise from all the tubercles, and white branching hairs from the upper side of the latter tubercles on segments 4 to 12 inclusive. These white hairs form elongated white spots along each side and are one of the most striking characteristics of this caterpillar. The subdorsal and lateral tubercles on segments 4 to 12 inclusive are covered with fine, short spines of uniform length. There is a bright red retractile tubercle on the top of the 10th, and also one on the 11th segment.

The pupae are ¾ inch in length, dark brown in color and with fine, yellowish brown hairs [pl. 1, fig. 4] scattered over the surface.

Habits of the caterpillars. The following account of the habits of these caterpillars is taken from a bulletin by Fernald and Kirkland, and is as follows:

The young caterpillars of the brown tail moth, after hibernating in the tents which they construct at the tip of the branches, emerge in the spring and feed downward towards the main branches and trunk, leaving the naked twigs bearing the gray tents at the ends, a conspicuous evidence of the presence of this insect. They eat the entire leaf except the midrib, and, in leaves having strong ribs, like those of the sycamore maple, all the larger ribs are left untouched. When the caterpillars are numerous they devour not only the buds, leaves and blossoms, but even the green fruit.

The caterpillars are quite gregarious up to the later stages of their growth, when they disperse to some extent; but when they occur only in moderate numbers, they retain their gregarious

habits to a greater degree than when they are very abundant, since in this case the supply of food is soon exhausted and they are forced to migrate. When these caterpillars molt, they gather in masses on the branches and cover themselves with a scanty mass of silk. When preparing to change to the pupal stage, several of the caterpillars spin up in a common cocoon within the leaves at the tip of the branches. When numerous, they frequently pupate in masses under fences and clapboards, or on the trunks and larger branches of the trees.

The webs of the brown tail moth should not be confounded with those of the tent caterpillar or the fall webworm. They may be distinguished from those of the tent caterpillar by being placed at the tips of the branches, while the tent caterpillar constructs its tent in a fork of the limbs. The latter insect rarely, if ever, attacks pear, which is a favorite food plant of the brown tail moth. The fall webworm, while often found on peartrees, spins a large open web at the ends of the branches and feeds within this web. This insect does not appear until after the brown tail moth has ceased to do damage.

Food plants. This species has been recorded on a considerable number of food plants, but, according to Professor Fernald, pear seems to be the favorite of this insect in the infested region, though winter webs have been found in addition on apple, quince, plum, cherry, peach, oak, maple, elm, rose and grape.

Irritation caused by the hairs. This has been referred to above; and, as there stated, is frequently very severe and annoying. Investigations by Mr F. J. Smith show that the trouble is a mechanical one, and is not, as at first was supposed, due to any poisonous irritant substance in the hairs. The nettling of the skin may be caused by contact with the caterpillars, both old or young, or the cocoons, though in the latter case contact is not necessary since hairs from them are blown about by the winds. Professor Fernald cites the statement of an English journal to the effect that travelers are often affected, when the wind blows strongly from infested hedges along the road.

Natural enemies. A number of parasites have been bred from the pupae in this country. Professor Fernald records the rearing of *Phaeogenes hebe* Cress., *Diglochis omnivora* Walk., *Euphorocera claripennis* Macq. and a large number of unnamed dipterous parasites. He states that the work of Diglochis is specially valuable and worthy of commen-

dation. He also records the destruction of the caterpillars by a soldier bug, Podisus serieventris Uhl.; states that the Baltimore oriole, black-billed cuckoo, crow, bluebird and English sparrow have also been observed feeding on these insects, and quotes Mr Kirkland to the effect that the birds eat not only the moths, but their young, and that it was no uncommon sight at Somerville to see flocks of 20 or more sparrows collect the moths from a picket fence. In addition to the above mentioned birds, Mr E. H. Forbush has recorded the robin, bluejay, black and white warbler, the rose-breasted grosbeak, the chestnut-sided warbler, the scarlet tanager, redstart, chickadees, red-eyed vireos, the yellow-throated vireo and the male indigo bird as feeding on the caterpillars. The records given by Mr Forbush include the number of larvae eaten by each bird and the time occupied. None ate less than nine, and one as many as 57 caterpillars, the latter operation occupying 20 minutes. These observations show that our native birds will undoubtedly prove to be very efficient aids in checking this pest. Professor Fernald has also recorded bats as feeding on the moths at night, and he states that toads devour the caterpillars during the early summer and the moths later in the season.

Remedial measures. The conspicuous hibernating nests [pl. 1, fig. 7] of this species are easily detected at any time when the foliage is off the trees, and one of the most effective methods of checking this pest is to cut them off and burn them. This can be very easily done with the aid of long handled pruning shears. The insect is also readily controlled with arsenical poisons; and Professor Fernald reports experiments in spraying with arsenate of lead, in which 1 pound to 150 gallons, killed 50% of the caterpillars in four days, 90% in seven days and all in 13 days. Treatment with the same insecticide, 2 pounds to 150 gallons, gave similar results, and, when 5 pounds were used to 150 gallons, 80% were dead within four days and all in nine days. The use of 10 pounds to 150 gallons resulted in the destruction of all the caterpillars in six days.

Spraying with paris green, 1 pound to 150 gallons, killed 4% in four days, 70% in six days and 90% in nine days, all being dead in 12 days.

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Psila rosae Fabr.

CARROT RUST FLY

Ord. *Diptera:* Fam. *Psilidae*

Celery roots infested with a dipterous larva, which subsequently proved to be this species, were received Dec. 30, 1901, from James Granger, Broadalbin, who states that the attack was confined to the roots and crown, never interfering with the stalk. Several larvae were taken from one root, and their burrows, about $\frac{1}{16}$ inch in diameter, were lined with reddish particles of comminuted tissue. The galleries were found in the roots near the crown and also in the crown and frequently ran obliquely for a distance partly around the root or crown, as the case may be, and in some instances they were near the center of the infested plant. The attack was a serious one, as is evidenced by the ruining of about 6000 plants. Traces of the insect were found all over a field containing some 60,000 plants.

Introduction and injuries in America. This is a European insect, which prior to 1885 was not known to occur in this country. It was then reared by Dr Fletcher from carrots purchased in the market at Ottawa, where the following year he found young carrot plants in a garden badly attacked. The same year a great deal of damage was done, particularly to stored roots

during the winter. Mr F. B. Caulfield, an entomologist in Montreal, reported that in February 1887 nearly all the carrots he had seen exposed for sale were more or less attacked. Early carrots were badly injured at Nepean Ont., nearly every root showing signs of the insect's presence, and two thirds of the crop was seriously injured, as stated by Dr Fletcher in his report for 1887. The species was reported in 1897 as occasioning considerable complaint during the previous 10 or 12 years, chiefly in the province of New Brunswick, but also in Ontario and Quebec. The attack was described as being a serious one, rendering useless roots stored for table use. A party at Rothsay, Kings co. N. B. noticed in 1895 that late sown carrots were less injured than those planted earlier, and since that time late sowing has been recommended and proved of considerable value, according to Dr Fletcher's report for 1897. Injury has also been recorded at Upper Sackville, Brookville and Clifton N. B., it being noticed in the first named locality in 1894 and 1895 and at Brookville during the latter year and at Clifton for several years. Few carrots had been grown in the last named locality during late years, on account of this pest, as stated by Dr Fletcher in his report for 1897. The following year he records specific injury to carrots at Noulton and Ste Marie Que.

The above summary of the insect's occurrence in this country, as well as some of the following matter, has been taken from Mr F. H. Chittenden's account in Bulletin 33, new series, of the division of entomology of United States Department of Agriculture.

Distribution. This species is a well known pest in England and Germany and probably occurs elsewhere on the continent of Europe. It was originally described from Kilia, Bessarabia. Just when it was first introduced in this country does not appear to have been recorded. Its ravages were not apparent however till 1894, and up to last year the insect appears to have been confined to Canada, though there is in the National Museum a single specimen received from Mrs A. T. Slosson, labeled Franconia N. H. There appears to be no record other than Mr Chittenden's, which relates to the same outbreak, of the species having been found previously in New York State, and celery is a new food plant for the pest. This divergence in food habits is not sur-

prising, since it frequently happens that a species introduced into a new country forms new habits and depredates on other plants. Mr Chittenden expresses the opinion that the insect has probably been established in Canada for at least 18 years and adds that it will probably not extend farther south than the upper Austral life zone.

Life history. The life history of this species does not appear to have been worked out. The insect undoubtedly passes the winter in puparia and, according to Mr Chittenden, possibly as larvae. Since the larvae work on stored roots, the flies may develop in winter, as occurred at Washington and also in our own breeding cages. This permits great irregularity in development and makes it impossible to accurately forecast the habits of the insect in the field. The flies probably develop rather early in the season and attack young carrots, which turn a rusty red color. An examination will show that the roots have been disfigured with rusty patches, specially toward the tip. Both the flies and maggots are found throughout the warmer months, but the latter desert the roots and pupate in the earth. It is very probable that the last generation in a season descends much deeper than the earlier ones. The life cycle is completed in three or four weeks, as stated by Curtis, and no one appears to have determined the number of generations which may be produced. Mr Chittenden is of the opinion that there are at least two and probably more, and we are inclined to think his estimate is a conservative one. Miss Ormerod states that the fly goes into the ground for oviposition wherever it can find a crack or other opening about the roots, and that the maggots, after hatching, work their way into the roots and even when quite small destroy the entire lower portion.

Description. The adult or parent fly is quite minute, measuring only about $\frac{1}{6}$ inch in length and with a wing expanse of little more than $\frac{3}{10}$ inch. The color is dark green, by some authors given as black, and the insect is rather sparsely clothed with yellow hairs. The head and legs are pale yellow and the eyes black.

The maggot or larva is pale yellowish white when half grown and when full grown presents a general resemblance to that of the cheese maggot, to which the species is somewhat closely related.

It is then much darker in color, being rather dark brown with well marked segments, a minute head and the posterior extremity truncate. The general appearance of the larva is shown at figure 1.

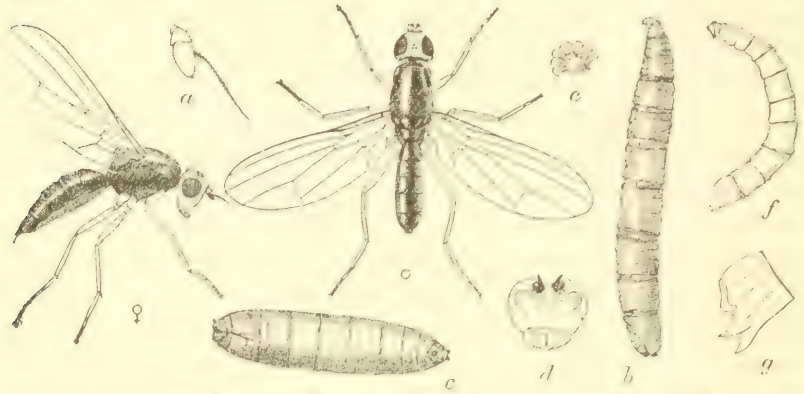

FIG. 1 Psila rosae: ♂ male fly. ♀ female fly: lateral view; *a*, antenna of male; *b*, full grown larva, lateral view; *c*, spiracles of same; *d*, anal extremity from the end; *e*, puparium; *f*, young larva; *g*, anal segment from side — flies, young and mature larva, and puparium, eight times natural size; other portions more enlarged. (After Chittenden, U. S. Dep't Agric. div. ent. Bul. 33, n. s. 1902)

Natural enemies. Very little has been recorded concerning the natural enemies of this species. Curtis found a small four winged fly which he described as Alysia apii and presumed was a natural enemy of this pest.

Remedial measures. This species, like others which exist under ground, is difficult to control with insecticides, and our principal dependence must therefore be based on cultural methods which may serve to avert attack.

The standard kerosene emulsion, 1 part to 10 of water, may be sprayed along carrot rows with knapsack or other sprayer. Sand, land plaster or ashes, with which kerosene has been mixed at the rate of ½ pint to 3 gallons, may be sprinkled along the rows. These, with the exception of crude carbolic acid, a pint in 5 gallons, are about the only substances which have given good results. Dr Fletcher states that in Canada one or the other of these applications should be made weekly during June from the time the roots begin to form, and particularly after the rows have been thinned.

Late sowing has also been practised to great advantage, and a number of persons have found it to be of considerable value.

Rotation of crops. This may be practised with comparatively little expense, and is very successful in checking pests of this character. The fields planted in successive years should be as far from others as practicable. Some of the most serious injuries have occurred on pieces where carrots have been grown year after year. Now that we know this insect breeds in celery as well as carrots, one should not follow the other. Clean cultivation should also be practised in order to destroy all remnants of either celery or carrots in which the insects may pass the winter.

Destruction of the insect in stored roots. The breeding of this species in stored roots suggests the advisability of destroying the larvae which forsake the roots and enter the soil to undergo their transformations, or the puparia. Where roots are packed in earth, the surrounding soil may be either buried deeply or spread out in thin layers where it will be exposed to the elements, or thrown into pools where it may be frozen, or exposed to heat or steam or any agency which will result in the destruction of the contained insects. These roots are also frequently stored in bins in cellars; and such inclosures, if nothing else be done, should have all openings protected by a fine wire screen, so that the adult insects can not escape to the open the following spring. It might be possible to fumigate such a cellar with carbon bisulfid or sulfur or hydrocyanic gas before opening it in the spring.

Fall cultivation. Mr Chittenden has recommended the light raking or cultivating of celery or carrot beds in the fall, so that the larvae or puparia may be destroyed by the frost. He also thinks that plowing early the following spring before the flies have had time to escape would result in destroying many of the insects.

NOTES FOR THE YEAR

The following brief account includes some of the more important insects brought to notice during 1902.

Special attention, as in the case of last year, has been given to forest and shade tree insects throughout the summer. Systematic collecting was continued at Karner, where there is an admirable growth of scrub oaks and small pines, and much valuable material secured, which will be reported on in another publication. The warm, sandy soil of Karner seems specially adapted for certain heat-loving insects; and last year we

were surprised at finding the large cicada-killer, Sphecius speciosus Drury, comparatively abundant.

Another southern species, Polyphylla variolosa Hentz, was found at Karner Aug. 4, 1902, by Mr Young. The specimen was dead, but in a good state of preservation, and was evidently native. This southern species has not, to our knowledge, been taken so far north in this state at least.

Another interesting capture was that of Cincindela punctulata Fabr, which was taken at Albany Aug. 4, 1902, by Mr Young.

The notes regarding the various species mentioned below have been grouped under convenient heads, as last year, so they may be of greater service to parties interested in the more practical aspect of this work.

Fruit tree pests

Appletree tent caterpillar, Clisiocampa americana Fabr. This species is annually more or less destructive in various sections of the State, and the season of 1902 has proved no exception to the general rule. Accounts of some severe injuries have been received from certain counties, and in others relatively little damage has been inflicted. Something out of the ordinary and worthy of record is reported by Mr J. F. Rose, of South Byron, who states that this common pest was extremely rare in Genesee county, and attributes the scarcity to the large number of wayside bushes killed by mice, which girdled them while protected by the heavy snows of last winter. The injury by mice was so extensive that almost every bush for considerable distances along the highway was killed in this manner; and the young caterpillars hatching from eggs on these bushes perished from lack of food.

Forest tent caterpillar, Clisiocampa disstria Hübn. The severe injuries to forest trees by this pest during the past four or five years have been gradually decreasing, and areas where the insect has been extremely destructive in earlier seasons have suffered comparatively little. The zone of greatest damage is apparently moving eastward in the case of Greene county. Some damage was inflicted on maple and orchard trees in eastern Greene and western Columbia counties during the past season, but the depredations generally speaking were not nearly so

severe as last year. The hard maples at Annandale, Dutchess co., suffered to some extent from the work of this pest; and, while the species was reported as being rare at Newport, Herkimer co., it was extremely abundant at Gravesville, only 7 miles north. A little damage by this insect was reported from Tompkins county. This record is somewhat different from that of last year and decidedly so from the one for 1900.

Bud moth, Tmetocera ocellana Schiff. This little insect appears to be on the increase in Genesee county according to the statements of Mr J. F. Rose, of South Byron, who considers it one of the worst pests of the orchard in that section of the country. The most dangerous feature in connection with this insect is the occurrence of the hungry, voracious, partly grown larvae on trees when the young foliage is developing, and when a small amount of feeding will produce a relatively large amount of damage. It can be controlled, as has been repeatedly demonstrated, by thorough spraying with an arsenical poison just as the buds are unfolding.

Apple leaf Bucculatrix, Bucculatrix pomifoliella Clem. This is a well known enemy of the apple in the western part of the State at least and is occasionally exceedingly abundant. Mr L. L. Woodford, of Berwyn N. Y., has recently called our attention to 150 trees which were very badly infested with this insect. Examples of the twigs accompanying his communication were nearly covered in places with the characteristic white or yellowish cocoons. The general appearance of the insect is represented in the accompanying figure. It may be controlled by thorough spraying in early June with an arsenical poison.

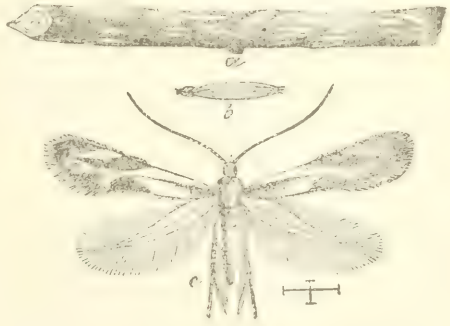

FIG. 2 Apple leaf Bucculatrix, Bucculatrix pomifoliella; *a*, piece of twig covered with cocoons; *b*, cocoon enlarged; *c*, the moth, enlarged

Small fruit insects

Raspberry cane maggot, Phorbia rubivora Coq. This species has been noticed from time to time on account of its

injuries to blackberry and to raspberry canes, and last May our attention was called to damage, probably the work of this insect, by Mr J. S. Kimberly, of Hamilton N. Y., who states that the maggots were quite destructive to blackberry and raspberry fields in that locality.

The parent insect is a small fly, and the most practical method of checking this species is by cutting the wilted tips well below the point of injury as soon as they appear and burning them.

The raspberry cane-girdler is a small beetle known as Oberea bimaculata Oliv., and works in a similar manner. It may be distinguished from the preceding by the fact that it does not begin its burrows till in June, and that the wilting is caused by series of punctures forming two rings around the cane from ½ to 1 inch apart, which the small beetle makes with its mandibles, and between which the egg is deposited. The latter insect may be controlled in the same manner as the preceding.

Grass and grain insects

Clover mite, Bryobia pratensis Garm. This little mite is a very common species and occasionally is present in immense numbers toward the end of the season, at which time it may cause serious injury by sucking the vital fluids from the leaves.

Mr L. L. Woodford, of Berwyn, has recently called our attention to what, for this State, is an abnormal abundance of the eggs. He states that one peachtree was so badly infested that many square inches of its surface presented a red color on account of the abundant eggs. In some places areas the size of a silver dollar appeared as if splashed with red paint. A twig, submitted with his communication, showed myriads of the characteristic eggs around every bud and at the base of each branch. They were so numerous as to give a distinct red coloring to an irregular area around each prominence. Dr C. L. Marlatt has recorded instances where the eggs were much more numerous on trees in the western states, but, so far as known to us, this species is not usually so abundant in the East. The eggs may be destroyed, as shown by experiments of Prof. C. P. Gillette, by spraying in winter with the standard kerosene emulsion diluted with but 5 parts of water. It is very probable that the 10% or 15% mechanical

crude petroleum emulsion would be just as effective and on some accounts preferable.

Corn worm or bollworm, Heliothis armiger Hübn. This southern species is well known on account of its serious depredations on cotton, and occasionally it is brought to notice in the northern states because of injuries to corn or tomatoes.

Dr M. W. Van Denburg, of Mount Vernon N. Y., reports this species as being unusually abundant in that section, where it occurred on sweet corn during the latter part of August. He states that the larvae eat the succulent husks, the kernels and also the juicy cob, leaving their burrows full of a brownish, moist excrement, in which they seem to be packed. He adds that the larvae occurred in about 10% of the ears.

Hessian fly, Cecidomyia destructor Say. The serious depredations of this grain pest were recorded in a preceding report; and the statement that practically no harm has been inflicted during the past season, not even in cases where white or no. 6 wheat was so seriously damaged the preceding year, is worthy of record.

Pea weevil, Bruchus pisi Linn. This little insect is a species which occurs somewhat commonly in peas, and its presence is too frequently overlooked or regarded as of comparatively little importance, and those planting a few peas or even growing them on a considerable scale, pay little or no attention to whether the seed is infested by this insect or not. As a matter of fact, this subject is one of considerable importance, particularly in Canada, where the species has caused enormous losses in recent years, and, unless repressive measures are adopted or enforced, it may cause much damage in the United States. Aside from direct injury, it is a well established fact that peas infested by this species have not the commercial value of clean seed, since, as determined by Dr Fletcher, only 17% to 20% of the infested ones will germinate. This means that where the weevil is at all abundant in the seed, one half to four fifths of it may be worthless; and purchasers will do well to bear this in mind. The sowing of this seed not only results in a less than normal number of plants, but also aids the propagation of the insect; and it is very probable that a great many of these pests are eaten in green peas — something which is not agreeable to contemplate.

The species can be easily controlled, since it is confined to one food plant, namely peas, and hibernates either within the seed or in sheltered places.

If the peas for seed purposes are harvested early, promptly threshed and treated with carbon bisulfid, none of the insects will be able to survive; and Dr Fletcher states that if the peas be tightly inclosed in a paper bag, the weevils will be unable to escape from their prison, and, if the seed be held over till the second year, which may be done without injuring its germinating powers, all of the weevils will die, and consequently there will be no danger of the species propagating. This simple method involves little or no additional expense; and, if the large growers of seed peas will in turn cooperate and fumigate all of their stock, there should be comparatively little or no trouble from the species in future years. It would undoubtedly be good business policy for growers of peas to print on each package a statement that the seed has been properly fumigated; and buyers are urged to insist on this treatment or to apply it to seed before it is planted.

Shade tree insects

Elm leaf beetle, *Galerucella luteola* Müll. This serious enemy of elms in the Hudson river valley has inflicted considerable injury during the past season, though it does not appear to have been quite so abundant in Albany and vicinity as in earlier years. It has also been reported as present in reduced numbers at Annandale, Dutchess co. It still ranks however as a pest of prime importance, and, where repressive measures, such as spraying with an arsenical poison, are not employed, many trees have sustained very serious injuries. The insect is gradually extending its range in the upper Hudson and lower Mohawk valleys, as is evidenced by its being widely distributed and quite injurious at Schenectady and also by its location recently in large numbers at Saratoga Springs. The latter outbreak is of considerable interest, because it is the most northern locality where very serious injuries have been caused by this species. It was hoped a few years ago that climatic conditions in this and similar localities would prevent serious depredations. This opinion has been refuted by its work in 1902; and it now remains to be seen whether the insect will prove to be seriously destructive for a

term of years. A recent note[1] by Prof. M. V. Slingerland states that this species occurs in small numbers at Ithaca N. Y.

White marked tussock moth, Notolophus leucostigma Abb. & Sm. This is one of the well known serious enemies of our shade trees in some of the larger cities of the State; and it is not unusual to see a number of horse-chestnut trees defoliated by the caterpillars. The cities of Albany and Troy have been comparatively free from this species in recent years, because in all probability, of the active measures employed for the control of the elm leaf beetle, which naturally resulted in other insects receiving the same treatment when their unusual abundance rendered it necessary. The work of this insect was exceedingly prevalent during the past season in the city of Buffalo, where it defoliated thousands of horse-chestnut trees over a considerable portion of the city. It was an exception to find one which had escaped injury, and the foliage of practically all of the trees was destroyed.

This species occasionally produces two generations a year in the vicinity of Albany, a fact which has not been previously recorded. The writer's attention was drawn to a number of the caterpillars of this insect on a small, soft mapletree in Albany in the early part of September. These were undoubtedly a second generation, and occasionally individuals of the same species have been met with here and there during the latter part of the summer. This is very interesting, since this species is known to produce two generations normally in Boston and New York, while at Albany and probably some distance south a single brood is the rule.

Fall webworm, Hyphantria textor Harris. This is one of the injurious general feeders, which is usually present each year in greater or less numbers in some section of the State. It was unusually abundant and destructive in the southern counties, particularly in Orange and Rockland, where its nests were very conspicuous in many trees. It was also reported as quite abundant and destructive in some of the western counties, specially in Genesee, where it was stated to be more numerous than Mr J. F. Rose had even seen before. This species is such a general

[1]Entomological News, Jan. 1903, 14:30.

feeder that under ordinary conditions it does not inflict serious damages, and is usually fairly well controlled by natural enemies.

Black banded Lecanium, Lecanium nigrofasciatum Perg. This small insect has previously attracted comparatively little attention in this State. It was noticed briefly in our previous report and was brought to the attention of Dr Lintner in 1896, by examples sent from Poughkeepsie, where it had been exceedingly abundant on a hard maple. It has been observed in relatively small numbers on soft maples in Albany till the last few years, when it has become plenty on certain trees, and during 1902 it was found to be present in immense numbers on many soft maples. The insects were so abundant that a large amount of honeydew was excreted, and the growth of the trees seriously checked by its work.

Forest insects

Willow and poplar curculio, Cryptorhynchus lapathi Linn. This destructive weevil has been quite injurious to nursery stock in western New York during the past season. Its presence is usually indicated externally, in the case of willows, by a purplish discoloration of the bark on either side of the transverse burrow and by the drying and shrinking of the thin bark directly over the gallery.

The full grown larva or grub burrows in the center of small stems, frequently for a distance of 3 or 4 inches, and the pupal cell is found near the extremity of this burrow [pl. 6, fig. 1]. The galleries of the young grubs occur around buds and at the base of small limbs and frequently partly girdle the tree. Their presence is not so conspicuous as the work of older individuals and is usually indicated by a brownish discoloration with a few minute borings near the entrance.

Larvae, pupae and adults were found in infested stock submitted for examination July 18. A number of adults were bred in the course of a few weeks. The insect was so abundant in some nurseries as to cause serious loss and, on account of its working within the stems, is a difficult one to control. The destruction by fire of badly infested trees appears to be the most practical method of checking it, though something may possibly be accomplished by spraying the stems of young willows and pop-

lars with a repellent insecticide, such as whale oil soap or the carbolic soap wash. These applications should be made about the first of July and probably repeated toward the latter end of the month, the time for second treatment depending somewhat on the amount of rain.

Nun moth, Psilura monacha Linn. Our attention has recently been called to the reported presence of this European insect at Brooklyn N. Y. According to the published account,[1] Mr George Franck stated that, on looking over the small collection of a local collector during the summer of 1901, he found among other material five individuals of this species, which he identified by comparison with European specimens, of which he possessed a number. The collector in question had no communication with others than Mr Franck, from whom he obtained material in exchange, and, when he was questioned regarding this species and its occurrence, Mr Franck was assured that the specimens had been captured at light in Brooklyn. No other person who had been consulted in regard to this species knew anything of its occurrence in that vicinity, and it was put down as an accidental importation, which is possibly true. The person who made the capture resides in a district where there are numerous lumber yards, and shipping is quite extensive. The location is described as being around North 2d street and Metropolitan avenue, near a creek which adjoins that portion of the bay running through the eastern part of Brooklyn. Since only five of the insects were taken, it may not be that the species has been introduced; but, as pointed out by Dr Howard, we may have here a parallel case to that of the gipsy moth, Porthetria dispar Linn., which was known to be actually introduced into this country 25 years before it attracted the attention of economic entomologists. The two species are related and have similar habits; and there is reason to believe that, if this species does become permanently established in the vicinity of New York, it will prove a serious enemy and perhaps be even more troublesome than the gipsy moth. The latter was established inland, while the nun moth, if it has obtained a foothold, will probably spread to the immediate vicinity of water ways on either side. This feature

1 Howard, L. O. U. S. Dep't Agric. div. ent. Bul. 38. n. s. 1902. p.90-91.

alone makes the matter of much greater importance, since vessels would afford the insect excellent opportunities to extend its range in this country, and there would be much greater difficulty, if it should become at all abundant, in limiting the spread of the species than was the case with the gipsy moth.

The parent insects are said to fly during July and August. The moths are a grayish or yellowish white, irregularly marked on the fore wings with dark brown or black, as shown on plate 6, figure 2. The hind wings are a pearly gray and margined with grayish brown spots. The abdomen is transversely marked with more or less distinct black bands interspersed with a reddish or rosy hue. The female has a wing spread of nearly 2 inches and the male about an inch and a half. The latter may be recognized by its smaller size and the pectinate antennae.

The larva has been described by Furneaux as follows: "The caterpillar is hairy, and of a grayish white color. A brown stripe runs down the back. On the top of the second segment are two blue tubercles; and there is also a tubercle, of a reddish color, on each of the ninth, 10th and 11th segments."

The larva has been recorded as feeding on a number of trees, notably oak, birch, fir, pine and apple, becomes full grown in June or July, and is specially injurious to spruce forests.

This species, as recorded by Myrick, is sometimes exceedingly destructive to fir forests on the continent, stripping the trees so completely as to kill them. A more detailed account of what this insect will do is given by Professor Fernow, now director of the New York State College of Forestry. He states[1] that the ravages of this insect in Europe from 1853 to 1867 involved an area of over 100,000 square miles and destroyed 55,000,000 cords of wood, necessitating the premature cutting of 7,000,000 cords to save it from subsequent attack by bark beetles. The attack in 1891 at first involved some 20,000 acres of spruce in upper Bavaria, but soon reports were received from all parts of Germany, Austria, Bohemia, etc., indicating an unusual abundance of the insect, so that many thousand square miles of forest were involved. Over $8000 were spent in the first named district in checking the ravages of the insect, and a special committee was

[1] Loco L. c. 89, p. 350.

appointed by the Bavarian government to discuss and advise measures to prevent the further spread of this species. The situation was so grave that the German government in 1891 appropriated $350,000 to fight this pest, most of which was expended on banding with an insect lime.

Walnut worm, Datana integerrima Gr. & Rob. This is our most common species belonging to the genus and one which is annually present in greater or less numbers in the western part of the State. It defoliated many butternut and walnut trees in Genesee county during last summer, as reported by Mr J. F. Rose, of South Byron; and our observations showed that it was also extremely abundant in Chautauqua county, where a considerable number of trees suffered severely from its ravages. Some of the smaller and worse infested trees lost most of their foliage, while the larger ones suffered to a less extent.

Birch leaf Bucculatrix, Bucculatrix canadensisella Chamb. The extensive depredations of this insect [pl. 6, fig. 3] in 1901 were noticed in a previous report. The species has not been quite so abundant during the past season, though in the vicinity of Karner a large proportion of the birches were practically skeletonized. State botanist Peck has also informed the writer that it was exceedingly injurious in the vicinity of Lake Placid. The work of the pest was so general in that section that clumps of birches could be recognized at a distance by their uniform brown color.

17 year cicada, Cicada septendecim Linn. The brood of this insect, due to appear in New York State the present year, was a very limited one; and the following localities, kindly communicated to me by Mr Chester Young, of Ellenville, are placed on record. The insects were observed by him at Wantagh, Nassau co.; also between Massapequa and Amityville, between Sayville and Oakdale, east of Patchogue to Brookhaven, and also to the north of Medford and Holtsville, and a small brood northeast of Riverhead, all in Suffolk county.

The writer has been unable to verify the occurrence of the insect in either Monroe or Niagara counties, where it had been reported in earlier years.

Household insects

Webbing or southern clothes moth, Tineola biselliella Hummel. This species is a southern form, which is stated by

Messrs Howard and Marlatt to be the more common one in the latitude of Washington. It also occurs farther north; and the breeding of it in considerable numbers from insects which had been in our collection for some years is worthy of record, though it is not a new habit, since the larva is known to feed on a variety of animal substances and has been previously recorded as occurring in collections. It was abundant enough in our own, so that one large moth was nearly destroyed, and a number of others injured, and it is apparently a form which would cause considerable damage if allowed to breed undisturbed.

Beneficial insects

Twice-stabbed Chinese ladybug, Chilochorus similis Rossi. The establishment of Aspidiotus perniciosus Comst. at San José Cal., and its subsequent spread to and injuries in many of the eastern states have led to active seeking for means of controlling this pest. Countless experiments with various insecticides have been carried out, and considerable attention has been given to ascertaining the original home of this species, in hopes that some natural enemy might be found there which would prove of great service in checking it. The personal investigations of Dr C. L. Marlatt in Japan and China in 1901 led this gentleman to conclude that the original home of this species was in northern China, and its most effective natural enemy in that section was the above named ladybug, and he shipped living examples of this species to Washington D. C., where they were carefully reared for the purpose of ascertaining their value. We were fortunate enough to obtain 50 adult beetles last August, and have since kept them on a badly infested tree inclosed in a tight, wire-covered breeding cage. The insects were placed on the tree Aug. 13, and a number of them were observed investigating young scales very shortly after being liberated. Examination Aug. 22 showed that the beetles were apparently healthy, though there were no signs of eggs or grubs, and some of the scale insects appeared to have been eaten. Early the next month one beetle was found, but no evidence of breeding was observed. Sep. 23 an examination by Mr Young resulted in finding about 150 larvae or grubs, which were working almost entirely on the southern side of the tree. There were more of the insects on twigs than on

leaves, and fewer scales were observed on the portion of the tree where the predaceous larvae were most abundant, since the scale insects were not clustered along the midribs of the leaves where the grubs occurred, as was the case in portions which appeared to be free from them. Oct. 17 the cage was again visited, and a few living larvae or grubs, together with two or three living beetles and a considerable number of pupae, were found. Five or six pupae were observed on the wire side of the cage, and there was considerable evidence of the larvae having eaten large numbers of the scale insects.

This species resembles our native twice-stabbed ladybug, Chilocorus bivulnerus Muls., so closely that only a specialist can separate the adults. There is more difference between the larvae of the two species, the skin of the imported form being reddish or a flesh tint, while that of our native species is dull gray. The larval spines of the introduced species are less prominent and differ structurally from those of our native ladybug. There appears to be no reason why our native species should not be equally valuable in checking this scale insect, but at present at least this introduced form seems to be much more effective, and it may prove to be an exceedingly valuable ally in combating this most pernicious scale insect.

Praying mantis, Mantis religiosus Linn. The distribution of the eggs of this beneficial species in a number of localities in the Hudson and Mohawk river valleys was recorded in our preceding report, and the statements of some of the recipients that eggs hatched and individuals developed were also published. It is worthy of record that the eggs of this species were reported by George S. Graves, Newport, as hatching June 22 of the present year, and Mr W. C. Hitchcock, Pittstown, states that a nearly full grown individual was taken by him Sep. 8, and that several others were observed by neighbors. There is a bare possibility of a mistake in some of the above records; and yet the appearance of this insect is characteristic, and, as each of these gentlemen were supplied with figures of the insect, it hardly seems as if there could be any doubt of the insect having become established in these two localities.

Chinese praying mantis, Tenodera sinensis Saussure. It is interesting in connection with the above to note that this large species has already become established in New York city and its vicinity, as stated by Mr L. H. Joutel.

This insect was first brought prominently to the attention of American entomologists in 1898 by Philip Laurent publishing a brief notice of its occurrence in the vicinity of Philadelphia in the issue of the *Entomological News* for June. In a later issue Mr Laurent states that he received the first specimen from Mr Mehan of the firm of Thomas Mehan & Sons in 1896. Later reports state that the insect has become well established in Philadelphia and apparently is able to hold its own in that climate. It appears to be thriving in the vicinity of New York city and may prove to be a valuable addition to our fauna, since it preys on other insects, and can hardly be otherwise than beneficial.

IMPORTANCE OF INJURIOUS INSECTS INTRODUCED FROM ABROAD[1]

One can not help being interested in the sources of our troubles; and the writer recently had occasion to look up some of the facts concerning introduced species, which, though they are well known, are worthy of further emphasis. It is generally conceded that some of our most troublesome insect pests are those which have made their way to us from abroad, and, while this is accepted as an authentic statement, its importance is not fully realized. The depredations of these introduced species are becoming more and more apparent, and the present indications are that in the future even more strenuous efforts must be made to subdue some of these insects. Let us glance briefly at the conditions in several portions of our country.

The commonwealth of Massachusetts now has within its borders two exceedingly injurious insects, which are bound sooner or later to make their way over a considerable portion of the United States. That commonwealth made a determined effort to exterminate the gipsy moth, Porthetria dispar Linn., and after the expenditure of over one million dollars abandoned the

1 Read before the Society for the Promotion of Agricultural Science at its meeting held in Washington D. C. Dec. 29, 1902.

task. The insect is now becoming more and more abundant, has established itself in Rhode Island and is gradually extending its range. The brown tail moth, Euproctis chrysorrhoea Linn., has also become established in that state, is known to occur in New Hampshire and Maine and is rapidly extending its range. The elms of that commonwealth are seriously injured by the imported elm leaf beetle, Galerucella luteola Müll., which has made its way over a considerable proportion of the state and is being assisted in its destructive work by the imported elm bark louse, Gossyparia ulmi Geoff. It would seem as if this might be sufficient, but apparently not, since the dreaded San José scale, Aspidiotus perniciosus Comst., is also established in a number of localities in that state and is proving true to its reputation in other places.

The condition of New York State is not much happier than that of its sister commonwealth, though as yet it is free from the gipsy and brown tail moths. Our elms, however, are badly injured from year to year by both the elm leaf beetle and the elm bark louse, and the shade trees in the vicinity of New York city are seriously ravaged by another imported insect, the leopard moth, Zeuzera pyrina Linn., a species which thrives in a large number of trees and when not checked inflicts extensive injuries. Our fruit trees are suffering here and there from excessive infestation by San José scale. The pear psylla, Psylla pyricola Forst., occasionally inflicts great injury on this fruit tree in various portions of the State.

In the South, we find the cotton boll weevil, Anthonomus grandis Boh., threatening the cotton crop of Texas, while the harlequin cabbage bug, Murgantia histrionica Hahn., has established itself in numbers in most of the southern states and is proving an exceedingly serious enemy of cruciferous crops. The imported peach scale, Diaspis pentagona Targ., is another recent introduction which has become established in several localities in the southern states and bids fair to rival in destructiveness the San José scale. It is also established in one or two localities in the north.

These are all insects which have been introduced into this country within comparatively recent years and which are proving pests of first importance. It is interesting in this connection to

observe where these and other introduced species first became established in the country. The gipsy and brown tail moths, Porthetria dispar Linn. and Euproctis chrysorrhoea Linn., were first detected in Massachusetts, while the elm bark louse, Gossyparia ulmi Geoff., the Hessian fly, Cecidomyia destructor Say, the common asparagus beetle, Crioceris asparagi Linn., the leopard moth, Zeuzera pyrina Linn., the Buffalo and black carpet beetles, Anthrenus scrophulariae Linn. and Attagenus piceus Oliv., and the European fruit tree scale insect, Aspidiotus ostreaeformis Curt., were first detected in New York State or its immediate vicinity, in the case of the leopard moth; and, according to recent reports, we may find that the nun moth, Psilura monacha Linn., has become established in the vicinity of New York city. Another imported insect, Coleophora limosipennella Dup., which may prove very destructive to elms, was recently brought to our attention on account of its occurrence in large numbers on Scotch elms in Brooklyn. The 12 spotted asparagus beetle, Crioceris 12-punctata Linn., was first detected in the vicinity of Baltimore, as is also true of the elm leaf beetle, Galerucella luteola Müll.

The few records given above indicate that a considerable number of the imported insects make their way to this country through the port of New York and naturally become established in the immediate vicinity of New York city or else at one of the great centers of the nursery trade in the western part of the State. Considerably fewer species come into the country through the port of Boston or through others south of New York. It may never be possible or practicable to attempt the establishment of a quarantine on our eastern coast, but it is certainly advisable for us to maintain a close watch (as is now done in New York by agents of the State Department of Agriculture) at these points of danger, in order that we may detect the advent of other injurious species and see that they are adequately controlled.

The injuries inflicted by the various imported insects are simply enormous and in most cases entirely beyond calculation. The

wheat midge, Diplosis tritici Fitch, inflicted in 1854, according to the estimates of Dr Fitch, a loss of $15,000,000 in New York State, or reduced the crop by about 7,000,000 bushels. A conservative estimate of the damage during the same year, by J. H. Klippart, secretary of the Ohio State Board of Agriculture, places the loss in that state at from 5,000,000 to 7,000,000 bushels. Two years later Dr Fitch estimated that from one half to two thirds of the wheat crop on the uplands of Livingston and Monroe counties was destroyed, and that nearly all of that on the flats, the latter comprising at least 2000 acres, was not harvested. Dr Fitch further states that the loss in 1857 probably exceeded that of 1854, and that one third of the entire crop, or about 8,000,000 bushels, was destroyed in Canada. The periodical injuries by the Hessian fly, Cecidomyia destructor Say, are well known, and it is not necessary to refer to them more than to mention that in 1846 it was estimated that in the western section of New York State there was a loss of not less than 500,000 bushels, and in our recent outbreak in 1901, the damage in New York State was placed at $3,000,000. Dr Marlatt has estimated that the loss in the Ohio valley on the crop of 1899-1900 amounted to from $35,000,000 to $40,000,000, and he places the minimum annual loss in the chief wheat growing sections of the country at 40,000,000 bushels and over. The exceedingly common codling moth, Carpocapsa pomonella Linn., is well known as a destructive insect; and it may be interesting to record Dr Forbes's estimate of $2,375,000 as the annual loss caused by it in the State of Illinois, while Professor Slingerland has placed the average damage in New York State at $3,000,000. In the southern states, enormous injuries by the cotton worm, Aletia argillacea Hübn., are well known. The average loss in the cotton states for the 14 years following the Civil War was estimated by Dr Packard at $15,000,000, and that for 1873 was placed by the same author at $25,000,000. Later, in 1877, he estimates the annual loss as ranging from $25,000,000 to $50,000,000. These are a few examples of what some of our introduced insect pests have done, and represent only a very small fraction of the entire loss, which in many cases can not be estimated with any approach to accuracy. It should perhaps be

added that the imported fluted scale, Icerya purchasi Mask., threatened the entire citrus fruit industries of California in the 80's and was effectually subdued only by the importation of natural enemies.

We have made an attempt to classify these imported insects according to their destructiveness or prospective importance; and the following annotated lists give our judgment regarding some of these forms.

INTRODUCED SPECIES OF PRIMARY ECONOMIC IMPORTANCE

Affecting fruit trees

San Jose scale, Aspidiotus perniciosus Comst. This species, though recently introduced, is already widely distributed over the United States and easily ranks as one of the most injurious scale insects in the country and is probably as destructive as any other imported form.

The black scale, Lecanium oleae Bern., is very injurious, particularly to oranges and lemons in southern California.

The codling moth, Carpocapsa pomonella Linn., is one of our older pests and yearly causes great losses, as mentioned in a preceding paragraph.

The brown tail moth, Euproctis chrysorrhoea Linn., is one of our most recently introduced species, which promises to be not only quite injurious to peartrees, but also very annoying to man, since the irritating hairs of its caterpillar have caused very serious inflammations, in neighborhoods where the insect was numerous.

The gipsy moth, Porthetria dispar Linn., though of comparatively recent introduction and still confined to a somewhat limited territory, is a species of prime economic importance and may eventually become one of the most destructive in the country. It fortunately spreads slowly and may be controlled locally.

The pear psylla, Psylla pyricola Forst., though first detected in Connecticut, probably entered the country through the port of New York and is exceedingly destructive to peartrees in some years. It has obtained a wide distribution in New York State and is known to occur as far west as Illinois.

Affecting shade trees

The elm leaf beetle, Galerucella luteola Müll., is a species which is at present confined largely to the Atlantic coast and during the last four or five years has been extending its range northward, particularly in New York and Massachusetts, where it has been exceedingly destructive, and easily ranks as one of the most serious enemies of elms.

The leopard moth, Zeuzera pyrina Linn., is limited largely to the vicinity of New York city, where it has proved very injurious to soft maples in particular, though it has been recorded as depredating on a great many other trees.

Affecting grains

The Hessian fly, Cecidomyia destructor Say, is a well known destructive species, which occasionally causes exceedingly severe losses and is more or less injurious every year in some section of the country.

The grain aphis, Nectarophora granaria Kirby, is exceedingly destructive in some years to grains in certain sections, and there is no practical method of controlling it.

A grain louse, Toxoptera graminum Rond., is a recent introduction and has proved very injurious to wheat in Texas.

Affecting cotton and other crops

The cotton worm, Aletia argillacea Hübn., is a well known and exceedingly injurious insect in the South.

Its associate, the boll worm or corn worm, Heliothis armiger Hübn., is exceedingly injurious and may have had a foreign origin.

The cotton boll weevil, Anthonomus grandis Boh., is a species which has recently become established in Texas, where it has already inflicted enormous damages and is proving exceedingly difficult to control.

The hop plant louse, Phorodon humuli Schrank, is a serious enemy of this crop, which occasionally causes very great losses and is more or less destructive each year.

The cabbage maggot, Phorbia brassicae Bouché, is very destructive to cabbages in various sections of the United States and has led to the abandonment by many growers of early cab-

bage, cauliflowers and radishes about New York city, according to Peter Henderson, who records the destruction of tens of thousands of acres in 1887.

The destructive pea aphis, Nectarophora pisi Kalt, is a species which has caused widespread loss to extensive pea-growers in the Atlantic states and has led many to abandon the late varieties in order to escape its ravages.

RECENTLY INTRODUCED SPECIES WHICH MAY BECOME VERY DESTRUCTIVE

The sinuate pear borer, Agrilus sinuatus Oliv., is established in the vicinity of New Brunswick N. J.

The recently imported West Indian peach scale, Diaspis pentagona Targ., is very injurious where established in the southern states and is known in a few localities in Massachusetts.

The European fruit tree scale insect, Aspidiotus ostreaeformis Curt., is established in New York State and in a number of other localities in this country, but as yet has not proved markedly injurious.

The wheat sawfly, Cephus pygmaeus Linn., has become established in several localities in this country, but has not proved very injurious, though it is a well known enemy of wheat in Europe.

An interesting case-bearer, Coleophora limosipennella Dup., was brought to the speaker's notice last year, when it was inflicting considerable injury on Scotch elms at Brooklyn. It is apparently a recently introduced species.

The willow and poplar curculio, Cryptorhynchus lapathi Linn., has become established in a number of widely separated localities and has proved quite injurious to nursery and other young trees in particular.

OTHER INTRODUCED SPECIES

Most of the forms included in this list are quite destructive at times, though not as a rule so injurious, or likely to become so, as those in the preceding lists. Most of them are so familiar that comment is unnecessary.

Species affecting fruit trees

Pear midge, Diplosis pyrivora Riley

Bud moth, Tmetocera ocellana Schiff.

Cherry and pear slug, Eriocampoides limacina Retz.
Apple aphis, Aphis mali Fabr.
Cherry aphis, Myzus cerasi Fabr.
Pear blight beetle, Xyleborus dispar Fabr.
Fruit tree bark beetle, Scolytus rugulosus Ratz.
Appletree bark louse, Mytilaspis pomorum Bouché.
Orange bark louse Mytilaspis citricola Pack.
Greedy scale insect, Aspidiotus camelliae Sig.
Fluted scale, Icerya purchasi Mask.

Species affecting small fruits

Currant sawfly, Pteronus ribesii Scop.
Currant stem borer, Sesia tipuliformis Linn.
Rose scale, Aulacaspis rosae Sandb.

Species affecting miscellaneous crops

Larger cornstalk borer or sugar cane borer, Diatraea saccharalis Fabr.
Common asparagus beetle, Crioceris asparagi Linn.
12 spotted asparagus beetle, Crioceris 12-punctata Linn.
Cabbage aphis, Aphis brassicae Linn.
Harlequin cabbage bug, Murgantia histrionica Hahn.
Onion maggot, Phorbia ceparum Meig.
Seed corn maggot or locust egg anthomyian, Phorbia fusiceps Zett.
Variegated cutworm, Peridroma saucia Hübn.
Xylophasia arctica Bdv.
Cabbage butterfly, Pieris rapae Linn.
Cabbage worm, Plutella cruciferarum Zell.
Imported cabbage webworm, Hellula undalis Fabr.
Carrot rust fly, Psila rosae Fabr., has been known in Canada for some years and was first detected in New York State in 1901.
Clover leaf weevil, Phytonomus punctatus Fabr.
Mamestra trifolii Rott.
Clover root borer, Hylastes trifolii Müll.
Clover hay worm, Pyralis costalis Fabr.
Prolific Chlorops, Chlorops variceps Loew.

Affecting forest trees

Larch sawfly, Lygaeonematus erichsonii Hart.

Woolly larch aphis, Chermes strobilobius Kalt.

Birch seed midge, Cecidomyia betulae Winnertz

The European willow gall midge, Rhabdophaga salicis Schrank, was recently detected by us in central New York, where it has caused considerable injury by infesting willows grown for binding nursery stock.

Golden oak scale insect, Asterolecanium variolosum Ratz.

Elm bark louse, Gossyparia ulmi Geoff.

Affecting domestic animals

Horn fly, Haematobia serrata Rob.-Desv.

Screw worm, Lucilia macellaria Fabr.

Enemies to stored food products

This list comprises a number of widely distributed species, a few of which are exceedingly destructive.

Mediterranean flour moth Ephestia kuehniella Zell. This species is the most destructive mill pest known in the country, and when abundant may necessitate the cessation of operations and thorough cleansing before grinding can be resumed.

Indian meal worm, Plodia interpunctella Hübn.

The rice weevils, Calandra granaria Linn. and C. oryzae Linn.

The bean weevil, Bruchus obtectus Say.

The pea weevil, Bruchus pisi Linn.

Insects annoying or injurious in houses

This group comprises practically all of our species, as may be seen from the following list.

Case-making clothes moth, Tinea pellionella Linn.

Southern clothes moth, Tineola biselliella Hum.

Tapestry moth, Trichophaga tapetzella Linn.

Buffalo carpet beetle, Anthrenus scrophulariae Linn.

Black carpet beetle, Attagenus piceus Oliv.

Larder beetle, Dermestes lardarius Linn.

Little red ant, Monomorium pharaonis Linn.

House fly, Musca domestica Linn.
The bed bug, Acanthia lectularius Linn.
The cockroach, Periplaneta orientalis Linn.
The American cockroach, Periplaneta americana Linn.
The croton bug, Phyllodromia germanica Fabr.

Beneficial species

The general record concerning introduced species is not pleasant reading, but that of the forms which aid in subduing insect pests is one of the brightest pages of American economic entomology. The first prominent success met with in introducing predaceous enemies was the importation of the Australian ladybug, Novius cardinalis Mul., which was introduced in 1889 in hopes that it would check the destructive fluted scale, Icerya purchasi Mask., which then threatened the entire citrus industry of California. These hopes were realized in a most gratifying manner, and the ravages of that scale are now a matter of history.

Another valuable importation is that of the fig insect, Blastophaga grossorum Grov., a species which is absolutely essential for the production of the best quality of figs, and its presence has made possible the growing of the celebrated Smyrna figs in California. This was accomplished largely through the division of entomology of the United States Department of Agriculture and is another of the signal triumphs of applied or practical entomology. Another very recent importation, which may possibly prove of greatest practical benefit to American horticulture, is that of the Chinese ladybug, Chilocorus similis Rossi, a species which feeds readily on the San José scale and may eventually prove a very efficient factor in controlling it.

A list of the more important beneficial insects which have become established in this country is as follows:

A parasite of the fluted scale, Lestophonus iceryae Will.
The fig insect, Blastophaga grossorum Grov.
Hessian fly parasite, Entedon epigonus Walk.
Scutellista cyanea Motsch., a parasite of the black scale insect.

Cardinal ladybug, Novius cardinalis Muls.

Australian ladybugs, Novius koebelei Olliff and N. bellus Blackburn.

Chinese ladybug, Chilocorus similis Rossi.

Black ladybug, Rhizobius ventralis Erich.

A predaceous enemy of bark borers, Clerus formicarius Linn., introduced from Europe in 1892 by Dr A. D. Hopkins as a valuable predaceous enemy of certain very injurious bark borers.

European praying mantis, Mantis religiosa Linn.

Chinese praying mantis, Tenodera sinensis Sauss.

The two latter were accidentally brought into the country; and, while we expect that in the main they will be beneficial, apprehension is felt by some, and their introduction may not prove to be an unqualified benefit.

EXPERIMENTAL WORK AGAINST SAN JOSÉ SCALE INSECT

The experimental work against this insect begun in 1900 and continued in 1901 was further prosecuted during the past season, and the results of earlier years were largely confirmed.

The lime, salt and sulfur mixture, about which considerable has been written in the past 12 months, was also tested, and some valuable data obtained under various conditions. The results in earlier years from spring applications of whale oil soap in combination with crude petroleum and kerosene or its emulsions were such that it was not deemed advisable to continue further work with these substances. The combination of the soap with petroleum reduced the insecticidal value of the latter and made a somewhat safer combination, but increased the cost of the emulsion, so that its use can be advised only when no mechanical emulsion apparatus is at hand. The kerosene and its emulsions proved so unsatisfactory in early spring applications that no further work was attempted with it.

Fall applications

All our previous work had been done in early spring just before the buds began to open or just as they were unfolding, and though the results were exceedingly satisfactory some tests with fall applications were planned. These were all made Dec.

11, 1901. The day was an ideal one, there being very little or no wind most of the time and the temperature ranging from about 30° in the shade to 68° in the sun. The trees were dry, and, despite the fact that there had been considerable cold weather and much snow the previous week, the trunks of the trees, even to the very base, were well exposed; consequently the insecticide could be applied to the greatest advantage. Most of this experimental work was limited to an exceedingly badly infested orchard of young appletrees near Albany. A number of these were dying and a considerable proportion of them were in extremely bad condition, owing to the work of this scale insect.

20% mechanical crude petroleum emulsion. This mixture was applied to 23 appletrees in the above mentioned orchard. The oil was obtained of the Derrick Oil Co. of Titusville Pa., and, after being drawn from the barrel, tested 41.1° on the Beaumé oil scale. The spraying was carefully done, and, under the exceptional weather conditions noted above, practically every portion of each tree was covered with the mixture. The sprayed trees were numbered 344-66, and their condition at the time of spraying was as follows: nos. 344–347, 349, 350, 353, 355, 355a, 357, 361–363 were all very, very badly infested with the scale, a large proportion of the bark being literally covered by the pest. Trees 348, 352 and 359 were dead. Tree 351 was very badly infested, and trees 354, 358 and 364 were rather badly infested. A few scales were to be seen on tree 360. 365 was badly infested, and only a stump remained of tree 356.

In addition to the appletrees named above a number of other kinds of fruit trees on adjoining premises were sprayed with the crude petroleum. Most of these trees were in a fairly vigorous condition, though a few were somewhat badly infested by the scale.

An examination of the appletrees in midwinter raised considerable apprehension and it was feared that the insecticide had caused serious injury, but investigation Mar. 10 showed that the crude petroleum had not damaged the trees so much as was feared. The tips of some branches were dead, and a number of trees had died during the winter; but, as most of them were in very bad condition on account of scale infestation, it is hardly fair to attribute all the damage to the insecticide applied. In

most instances the living bark of the trees ranged from slightly green to a perfectly healthy green, and it was then expected that a goodly proportion would develop a fair amount of foliage. All the scale insects appeared to be killed. One peachtree in an adjoining orchard, which had been sprayed at the same time and under similar conditions with the 20% mechanical emulsion, was examined in March, and it was found that the fruit buds had apparently escaped all injury.

An inspection of the same trees May 6 showed that a number had died, though this is not surprising after allowing for the injuries by the scale insects and also for the damage done by the round-headed borer, which was exceedingly abundant in the orchard. The trees sprayed with the crude petroleum emulsion showed little or no more injury than those beside them treated with whale oil soap, and we are therefore inclined to believe that the petroleum inflicted relatively little injury.

This mechanical emulsion, as previously stated, was applied under the same conditions to other trees, and the observations made on them are of considerable interest. May 6 these other sprayed trees were examined with the following results. A Dutchess pear showed a few dead limbs, was not badly infested and bade fair to produce some blossoms. Another of the same kind was leafing out nicely and gave evidence of producing a number of blossoms. A Globe peachtree presented a very fair bloom, though some limbs were dead at the tips. The latter we are inclined to believe was due to the weather of last winter, because similar injury was observed on a number of untreated trees. Meeches prolific quinces, of which several bushes were treated, were in excellent condition and had an abundance of flowers. Several Bartlett peartrees possessed a very good foliage and an excellent bloom.

These and some other trees treated with crude petroleum emulsion the preceding December were also observed June 12 with the following results. A Lombard plumtree was found to be nearly uninjured by the oil, while several Clapp's favorite peartrees were hurt to some extent, the bark cracking in places in the case of one tree and none bearing any fruit. Some injury and no fruit was true of a Bartlett peartree, while another bore considerable fruit and two others some. A Botan plumtree had

several limbs killed by the oil, but the others were apparently all right. A Kieffer peartree was in excellent condition and had a little fruit. One Dutchess pear was apparently uninjured and bore no fruit, while another would produce some. Practically the same results were obtained on Beurre d'Anjou and Vermont Beauty peartrees. The Meeches prolific quince-trees bore out the promise of an earlier date and gave no evidence of having suffered in the slightest from the application. A yellow Gage plum was in excellent condition but bore no fruit, and the same was true of a natural cherry, except that it had a little fruit. A Magnum Bonum plum was in excellent condition and bore considerable fruit.

An examination of the apple orchard June 12 failed to reveal a single living scale insect; and, though some of the trees had developed adventitious shoots, their occurrence could hardly be attributed to the use of the oil, since they were almost equally common on the trees sprayed with whale oil soap. The plum-trees sprayed with the crude petroleum also developed a considerable number of adventitious shoots, and it is possible that they were injured by the oil, though such is not necessarily the case.

An examination of these trees Nov. 11 by my assistant, Mr Walker, showed that a few were very badly infested by the scale, that some were badly infested and that several were dead. The owner, since the treatment of the previous fall, had set a number of new trees in vacant places. Most of these and some of the others were in good condition.

In passing judgment on this experiment, it should be remembered that no treatment whatsoever was given after the spraying in December, and that, before the end of the season, the few scale insects which presumably escaped destruction had an excellent opportunity to multiply. Up to the middle of the summer at least there were very few living scale insects to be seen on these trees; and we can not help feeling that, while the insects are now abundant on a number of the trees, the application proved very efficient and was perhaps as effective, though somewhat injurious, as any spray which could be applied.

Good's caustic potash whale oil soap no. 3. This insecticide was applied at the rate of 2 pounds to the gallon to 315–28 and

331-43 in the above named young apple orchard and under conditions previously described. The condition of these trees so far as noted at the time of treatment, Dec. 11, 1901, was as follows. Trees 317, 320, 321, 322, 323, 324, 325, 326, 327, 333, 334, 335, 336, 338, 340, 341 and 342 were extremely badly infested with the scale; trees 319, 330, 332 and 343 were very badly infested, and trees 316 and 331 were rather badly infested; there were only a few on tree 339 while trees 315, 318, 328 and 337 were dead. 34 other fruit trees on an adjoining place were also sprayed with this solution, except that a little of Good's tobacco whale oil soap no. 6, 2 pounds to the gallon, remained in the barrel when the solution of no. 3 was added. There was however very little of the tobacco whale oil soap solution, and the effect would hardly be modified.

The examination of the above mentioned trees Mar. 10, 1902, showed that apparently all of the scale insects had been killed by the treatment, and so far as noted no injury to the trees occurred. The same was true of a later examination made May 6, and there was no material change in conditions so far as noted June 12. An examination of the appletrees Nov. 11, 1902, by my assistant, Mr Walker, showed that a few of the trees were very badly infested, some badly infested and others in good condition. The application appears to have checked the pest very thoroughly till toward the latter end of the season, when the few which survived the treatment were able to multiply and reinfest the trees to a considerable extent.

Good's tobacco whale oil soap no. 6. This compound was used in a solution of 2 pounds to the gallon and was applied to 11 small appletrees in the above described orchard and to nearly 20 greengage plumtrees on the northern boundary of the same. The condition of the appletrees at the time of spraying was as follows. Trees numbered 303, 307, 308 and 313 were very very badly infested. Trees 305, 310 and 314 were dead except in the case of 310, which had developed a few suckers; 311 was nearly dead. There were a few scales to be seen on trees 304, 306 and 312, and 309 and 311 were very badly infested.

An examination of these trees Mar. 10 showed that apparently every scale insect had been destroyed by the application, and the same was true of a later examination May 6. This condi-

tion was not materially changed June 12, and an examination Nov. 11 by my assistant, Mr Walker, showed that two were very badly infested, some others badly infested and a few in a good condition. This row of trees was in such bad condition at the outset, and so many of them were nearly dead or had died during the winter, that the actual record does not do justice to the insecticide. Comparative observations led us to believe that this tobacco whale oil soap solution was possibly a little more effective in destroying scale insects than the more commonly employed caustic potash whale oil soap no. 3.

Linseed oil. Several trees were carefully painted with this substance Dec. 11, 1901, by my assistant, Mr C. M. Walker. The treated trees were as follows: tree 226, a small apple, and 227, a small peach, and 330, a very badly infested appletree, were painted with the boiled linseed oil. The raw linseed oil was similarly applied to an exceedingly badly infested appletree, no. 329. It was found that a small tree required about $\frac{1}{2}$ pint of the oil, and nearly two hours were occupied in applying the substance.

Mar. 10 the linseed oil could be easily seen on treated trees, and on May 6 it was seen that two appletrees, 329 and 330, were in a very serious condition and likely to die. June 12 it was found that 330, which was painted with the boiled linseed oil, was killed back to the stump and was then developing a very few shoots, while tree 329, which received the raw oil, was dead. This substance undoubtedly killed the scales and was apparently almost equally destructive to the trees. Its use in the fall certainly can not be advised.

Spring applications

The tests with various sprays in early spring were continued last spring, and the results of earlier years have been largely confirmed.

20% mechanical crude petroleum emulsion. This mixture was applied Ap. 7 to about 70 trees, representing a number of the more common varieties. The day was cloudy, and the trees were damp at 11 a. m., so that no spraying was undertaken till 1 p. m., at which time the trees were dry, though it was not what would be characterized as a drying day. The buds of some varieties of

pears had begun to open. This insecticide was applied to the following trees: 15-28, 34-47, 60-74, 79-91, and 101-14, or in other words, to the western end of our experimental orchard, a map of which was published in our report for 1900. The general character of the trees and their varieties have been previously published and can be ascertained by referring to the above report. Tests of the mechanical dilution were made while the work was in progress with the following results. At tree 19, 5% oil was delivered; at tree 87, a little over 12.3%; at tree 108, 14%; at tree 104, 12.5%; and at tree 35, 21.5%. Tree 83 was resprayed, because very little oil was delivered with the apparatus at the first attempt on account of the petroleum being low in the reservoir. The above figures vary much more widely than those of any tests previously made with this apparatus, and their divergence may have been due to the pump being somewhat out of order, though the precise trouble was not located.

The next day it began to rain about 10 a. m. and ceased about noon, beginning again at 1 p. m., and poured from about 1.30 to 2 p. m., but it did not cease raining till 3 p. m. On the 9th it rained some during the night and drizzled or rained most of the time between 8 a. m. and noon. It rained some most of the afternoon and during the night, and on the 10th it rained from 11 a. m to 3 p. m., also during the night and on the nights of the 11th and 12th. The weather bureau records at the Albany station, less than 3 miles from the experimental orchard, give the precipitation as follows: .01 in. on the 7th; .22 on the 8th, .35 on the 9th and .20 on the 10th, a total of .78 in. or practically one third of the rainfall during the month on the day of and the three following the application.

An examination of the trees sprayed with oil showed that they were apparently well covered, and the smell of petroleum was very marked in the orchard. The rough bark on some of the trees seemed to have absorbed the oil pretty thoroughly, but on the smooth bark there was an abundance, as very little or none had evaporated. The oil remaining on the trees for so long a period with comparatively little evaporation was most favorable to injury if such would be produced, and consequently a number of the trees were examined closely May 6, with the following

results. Tree 113 was in very full bloom, showing that the fruit buds had suffered no injury. Tree 114 had a number of open blossoms and many unfolding buds. The latter had been seriously injured by the scale in earlier years and was recovering very nicely [pl. 2]. Tree 47 had many blossoms on it, though they were somewhat sparse, while 41 produced a very large number. Tree 101 bore a considerable number of opening blossoms. Trees 17-19 showed a slight blistering on the smooth bark, due probably to the application of crude petroleum, but, so far as could be discovered, no appreciable injury had been done. It should also be stated that the bloom of peachtrees in general was not full, so that a scarcity on the sprayed trees was not necessarily due to the insecticide used [pl. 5].

An examination June 12 showed that the petroleum was still apparent on the trees, but signs of its presence were limited very largely to a darker, more moist appearance of the bark. There was very little or no odor of the oil in the orchard.

An examination June 20 showed that tree 28 bore some living females, and that young were found under the scales in small numbers. Tree 73 was very badly infested with young scales last spring, and these had been mostly destroyed. Living females were found only on the underside of the branches, in places where they were badly incrusted. The bark of this tree had cracked to some extent, probably owing to the oil. Trees 23 and 60 had some living scales, and the bark of each was very rough. Tree 103 was in excellent condition and had made a very satisfactory growth, for in 1900 it was very badly infested, and now the bark on the lower limbs and trunk is very rough. Tree 101 has a poor shape, owing to the death of limbs, resulting in all probability from the application of undiluted crude petroleum in 1900, but it is now making a fine growth. It has thrown out many suckers, which is due probably to its previous hard treatment. The bark of the lower limbs and trunk is very rough.

A detailed examination of these trees was made July 5 with the following results. There were few or no young on the following trees, 17, 19, 24, 26, 27, 34, 35, 42, 45, 46, 60, 62, 63, 64, 66, 70, 71, 74, 80, 81, 87, 88, 89, 90, 91, 101, 102, 103, 104, 109, 110, 111, 112, 113; there were few or very few young on the

following trees, 18, 25, 36, 37, 38, 40, 41, 43, 47, 65, 79, 82, 83, 84, 85, 105, 106, 108; young were rather abundant on trees 15, 16, 21, 22, 23, 28, 44, 61, 68, 69, 114; and young were very abundant on tree 73.

These trees were again carefully inspected Nov. 11 by my assistant, Mr Walker, who rated them as follows. Condition good, trees 15, 16, 17, 18, 19, 24, 25, 26, 27, 34, 35, 36, 37, 42, 43, 44, 45, 47, 60, 61, 62, 63, 64, 65, 66, 68, 71, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 101, 102, 103, 104, 105, 106, 109, 110, 111, 112, 113, and 114. The following were classed as being in a bad condition, that is having on them a number of living scale insects, trees 21, 22, 23, 38, 40, 41, 69, 70, 108; and trees 28 and 73 were rated as being very bad.

It will be seen by the above that only two trees were in very bad shape at the end of the season, and both of these were badly infested when the spraying was done last spring. Many of those classed as being in bad condition have the bark of the larger limbs and trunk rough, and this interferes materially with the efficiency of the insecticide. A comparison of the condition of these 70 trees with the 50 at the other end of the orchard sprayed with lime, salt and sulfur mixture is quite marked and emphatically in favor of treatment with the oil. It should be stated however that the relative inefficiency of the lime, salt and sulfur mixture was probably due to the rains following so shortly after application and continuing so long [*see* page 132]. These had practically no effect on the oil and therefore gave it the advantage.

The writer at the outset raised the question as to the possibility of injury resulting to trees which had been sprayed with petroleum for successive seasons, and now he is in a position to supply a little data on this question. Trees 25-28, 41-47 and 101-14 have received applications of crude petroleum for three successive seasons. Tree 101, a seckel pear, was very badly infested in 1900 when it was sprayed with undiluted petroleum and sustained serious injuries. The following year it was sprayed with a mechanical mixture, consisting of 15% oil and a whale oil soap solution, 1 pound to 4 gallons. Last spring it was sprayed with the 20% mechanical emulsion. This tree was in very bad condition at the outset, and, as above noted, was

seriously injured by the first application. It has been steadily improving and now is in a vigorous condition, has developed a large amount of new wood and bids fair in another year or two to have a symmetric, good sized head. The twigs made a growth of 8 to 12 inches during 1902 [pl. 3]. Tree 114, a pear of the same variety, was sprayed in 1900 with undiluted crude petroleum but was not injured so much as no. 101. It was treated last year with 20% mechanical crude petroleum, which was obtained from Titusville, and this year again with a 20% petroleum emulsion. It is in vigorous condition and much better off than two years ago [pl. 2]. Tree 69, a Howell pear, was treated in 1900 with whale oil soap and petroleum and with a mechanical emulsion of the latter in 1901 and 1902, and is now flourishing [pl. 3]. The same is practically true of tree 66, a Bartlett pear [pl. 2]. Tree 25 is a Beurre Bosc pear, which was very badly infested in 1900. Trees 26 and 27 are Kieffer and tree 28 a seckel pear; the latter was also very badly infested in 1900. At the end of 1900 young were reported as abundant on tree 28, and the same was true at the end of 1901. The very bad condition of the tree at the end of 1902 is probably due to the fact that it is in a corner which was rather difficult of access, and this may have had some influence on its treatment in earlier years. Tree 41 is a Crawford peach, and trees 42-45 and 47 are Old Mixon peachtrees. Trees 42 and 43 were very badly infested in the spring of 1900, but since then have developed little scale, and all are in as good, if not better, condition than two years ago last spring, and several of them bore very fair crops of fruit this year [pl. 5].

These cases go far toward showing that successive applications of crude petroleum, if carefully made, will not injure trees, and that those which are very badly infested can be freed from the scale to a considerable extent and brought into a profitable bearing condition.

Experiments at Highland. A 20% mechanical crude petroleum emulsion was applied Ap. 1 to 52 plumtrees, mostly Abundance and a few Burbank. The trees had been covered with ice and snow by a storm during the night and had just dried. The weather at the time of spraying was sunny, rather cool, and considerable wind was stirring, but the trees were well covered with

the insecticide. Samples of the emulsion taken near the beginning, the middle and end of the spraying gave respectively 17%, 13.6% and 15.6% of oil. These samples were taken while spraying under a reduced pressure and from both nozzles. This variation is greater than any recorded in previous years and may have been due to the apparatus being somewhat out of order. Sunday, the 6th, 7/8 inch of rain fell, and between that and the 11th, 1¾ inches more. The weather was such that no spraying was attempted between the initial application and the latter date.

An examination July 7 showed that about all of the trees sprayed with the emulsion were infested with from very few to rather abundant young scale insects. They were found almost entirely near the center of the rows. There was no evidence to show that the fruit buds had been affected in the slightest by the application.

An examination Nov. 25 showed that the trees were in very good condition. There were a few living scales on every one, and in a few cases they might be classed as somewhat abundant, but in no instance were there enough to interfere with the health of the tree. The general results were very satisfactory. All of the treated trees were in very thrifty condition and bore immense numbers of fruit buds.

Experiments at Warwick. About 50 old peachtrees were sprayed with 20% crude petroleum emulsion on Mar. 25, which was a bright, sunshiny day, though in the afternoon there was some wind. The trees in this old orchard are from three to five or seven years of age, some of them being 15 feet high. Two rows of small, three year old peachtrees, about 60 in number, on a hill, were also sprayed on the same day for the special purpose of ascertaining the effect of the insecticide on the fruit buds. The wind blew some, and practically all of the trees were well covered with the insecticide. Samples of the emulsion were taken at the beginning, middle and end of the spraying in the old orchard and gave respectively 21%, 36% and 32% of oil. This variation must have been due to the taking of the samples from one nozzle and under a lower pressure than that employed in most of the spraying. Another sample taken in the middle of the spraying of the two rows of young trees on the hill gave but 14% of oil.

An examination July 8 showed that the trees near the northern end of the old orchard have very little or no scale, except in one instance. In this case the tree was very badly infested, the bark was quite rough, and the living young were very abundant. Quite a number of the treated trees bore considerable fruit. The trees in the young orchard showed very little or no injury except in a very few cases where possibly an excessive amount of oil was applied. A very few living scales were found on some of the trees and none on many.

An examination Nov. 24 did not give satisfactory results in the old orchard, since some of the trees were comparatively free from living insects, while others were rather abundantly infested. The latter, however, were trees with very rough bark, which probably had considerable to do with the insects escaping destruction. The condition of the trees in the young orchard on the hill was much more satisfactory, and there were very few scale insects to be found on those sprayed with the oil. The trees did not show the slightest injury, except in one or two instances, and this may have been due to other causes, since they had made an excellent growth during the summer and had developed numerous fruit buds.

Summer spraying. The application of even a mechanical crude petroleum emulsion to trees in full foliage has not been recommended in the past, and the writer does not feel justified in doing so at present, in spite of the fact that his attention was called last summer to a very badly infested peach orchard in the southern part of the State, which had been sprayed while in full leaf with 20% and 25% mechanical crude petroleum emulsion. The applications were made at this time because it had just been discovered that the orchard in question was very badly infested with the San José scale, and it was felt that even heroic measures should be resorted to in order to check the pest. The spraying was done July 7, and the following day many of the trees were literally dripping with the oil, and the same was true of the weeds underneath, though we failed to note any injury. This work was done on the recommendation of Mr P. L. Huested, San José scale inspector of the State Department of Agriculture, and this gentleman reports that, so far as he has been able to discover, the trees have not suffered from this treatment, except that con-

siderable foliage dropped from parts where it was thickest and evaporation presumably much slower. This was particularly true where the 25% emulsion was freely used.

Good's whale oil soap no. 3. About 35 peachtrees in the old peach orchard at Warwick were sprayed with this substance, using 2 pounds to the gallon. The application was made on Mar. 24 and 25, and the weather was bright and sunny, and there was practically no breeze while the spraying was in progress. No rain fell till Friday afternoon, the 28th, when it commenced to drizzle, and it poured during the night.

An examination of these trees July 8 showed that there were very few living young on those near the northern end of the orchard. There were perhaps a few more scale insects than on those treated with the lime, salt and sulfur mixture. The setting of the fruit was apparently unaffected by the application. A number of young trees in the young orchard on the hill, sprayed by Mr Williams with this substance, using 1¼ pounds to the gallon, had a few scales, while many were perfectly free. The application was hardly as effective as the crude petroleum. Some unsprayed trees on the eastern side of this small orchard had from a few to many scales, while there were very few or none on most. It should be stated that the San José scale does not appear to have thriven in the orchards where the experiments were conducted, and consequently the results are not so decisive as might be wished.

An examination Nov. 24 failed to give anything decisive in the old orchard, where conditions, so far as experimental work was concerned, were far from satisfactory. The trees, generally speaking, were in better shape than those sprayed with the crude petroleum, and in nearly as good condition as those treated with lime, salt and sulfur. The most marked results were observed in the young orchard on the hill, where a large number of the trees, as previously stated, were sprayed last spring with 1¼ pounds of soap per gallon. These trees were not, generally speaking, as free from the scale as the young trees which had been sprayed with the mechanical crude petroleum emulsion, but none of them were seriously infested, and a great many were comparatively free from living insects. There was a striking difference to be observed between these and others which were

not treated. The latter were in some cases very badly infested, having entire limbs nearly incrusted with thrifty scale insects.

Lime, salt and sulfur mixture. This compound was applied to about 50 trees in the eastern end of our experimental orchard; and the results obtained from this test differ somewhat from those in other parts of the State under somewhat different conditions. The following formula was used: 10 pounds of lime and 20 pounds of sulfur were thoroughly boiled in 20 gallons of water for one and one half hours, or till the sulfur was dissolved, which was indicated by the solution assuming an amber color. This mixture was stirred frequently during the boiling, and then 30 pounds of lime, which had previously been thoroughly slaked by pouring hot water over it, and in which 15 pounds of salt had been dissolved by stirring, was added to the boiling lime and sulfur mixture. The whole of this mixture was cooked half an hour, being thoroughly stirred from time to time, and then enough water was added to make 60 gallons. The mixture was thoroughly strained through gunny sacks and sprayed as soon as possible, so as to apply it when hot. The mixture used in the experiments under consideration was boiled very thoroughly, and there can be no question as to its having been properly prepared.

Trees 4-14, 29-33, 49-59, 75-78 and 92-100 were treated with this preparation, as well as 20 to 25 large plumtrees in an old orchard just north of the experimental plot. The work was completed about 5 o'clock in the afternoon, and no rain was observed to fall till about 10 o'clock of the following day. There was however very little drying of the spray, since the atmosphere was humid most of the time. The exact record of precipitation is given above under the 20% mechanical emulsion, p. 132.

An examination of these trees Ap. 11 showed that, while they were apparently well covered with the mixture, in reality the rain had washed the finer portions against the rougher projections on the bark and had also caused it to gather in masses on the smooth bark of the limbs. It is very probable that much of the more soluble material had been carried away, or deposited in spots here and there on the tree, much to the detriment of the application.

An examination of the treated trees May 6 showed that the signs so visible on the previous inspection had nearly disappeared. The only indication of the presence of the insecticide was a somewhat bluish color, except in the case of one or two trees, where the lime, salt and sulfur solution appeared to have lodged in masses and gave the trunk a somewhat speckled condition. Tree 4 produced a large number of flowers [pl. 4], and 95 had a very fair bloom.

An examination of a few trees June 20 showed that there were many living young on the underside of the limbs of tree 14. There were some living scales to be found in some positions on tree 13, and living females were abundant on the underside of the limbs of tree 12.

A detailed examination of the trees was made July 5 with the following results. There were few or no young on trees 4, 5, 6, 8, 31, 50, 55, 56, 57, 58, 76, 96, 97, 98, 99; there were few young on trees 10, 13, 32, 33, 49, 51, 59, 92; young were rather few on trees 29, 30, 52, 77 and 100; they were rather abundant on trees 7, 11, 14, 53, 78, 95; and they were very abundant on tree 12.

Examination of these trees Nov. 6 by my assistant, Mr Walker, led him to rate them as follows. He found live females and young on trees 4 and 5 and dead young on number 6; numbers 7-14 inclusive were in very bad condition; the same was true of 29-33 and of 49-53, 55-59, 76-78 and 95-98. The status of tree 54 was doubtful, and 93 and 94 had been removed. No living scale was found on tree 92.

This is quite different from the other end of the orchard, and it was so marked that it was comparatively easy to distinguish between those treated with the lime, salt and sulfur and those with crude petroleum, simply by the number of scale insects on them. It should be pointed out however that this test was an unusually severe one; and, while these facts tend to throw considerable doubt on the value of this material, they do not condemn it. It is possible that the lime, salt and sulfur mixture will prove to be one of our most valuable methods of controlling this scale insect, since Mr L. L. Morrell, of Kinderhook, who used the material under the writer's directions, obtained most satisfactory results, and reports from others have

been equally good. It will require more than one season's work to determine the exact status of this material in New York State, and at present we can only advise its use in a provisional manner.

Experiments at Highland. A number of young plumtrees, 13 Abundance and 13 Burbank, were sprayed Ap. 1 with the lime, salt and sulfur mixture prepared according to the formula given above. Some trouble occurred in this case, because the boiler was small and would not hold 10 gallons at once. It was therefore impossible to add all the lime and salt and boil for half an hour. The matter was further complicated by the boiler leaking after a part of the lime and salt had been added and boiled perhaps for 25 minutes. The whole had to be removed, placed in a barrel, the additional lime and salt added, and then to that was added considerable hot water, and the mixture covered and allowed to remain undisturbed perhaps an hour in the hope that the heat would complete the chemical action. The trees sprayed with this mixture were completely dry. The day was sunny and rather cool with considerable wind. All of the trees were sparsely infested with San José scale. No rain fell till the 6th, when there was a precipitation of 7/8 inch, and from then to the 11th an additional 1¾ inches fell. The weather was such that no spraying had been possible since the first treatment.

An examination of the sprayed trees July 7 showed that there were very few living young, and that the mixture was apparent on the trees only as slightly white particles, which rendered the detection of the white, young scale insects very difficult. The application has undoubtedly killed a large proportion of the insects. Some other trees sprayed with lime, salt and sulfur, said to have been prepared according to the same formula but boiled only about half as long, were examined. The insecticide was much more apparent on the latter, and possibly it was more effective. In neither case did the mixture injure the fruit buds.

An examination Nov. 25 showed that the experimental trees were in excellent condition and, if anything, perhaps a little freer from the scale than those treated under similar conditions with the 20% mechanical petroleum emulsion. The trees above the experimental row were also sprayed later with lime, salt and sulfur mixture, which was boiled for a relatively short time, and considerable of the mixture was still to be seen on the northeast

side of the trunks and also on the underside of the larger branches. The condition of these trees was nearly as satisfactory as those of the experimental row sprayed by the writer.

A large number of trees below the experimental rows were also sprayed later with the lime, salt and sulfur mixture, which had been boiled till the amber color was very apparent, and the application was fully as thorough, according to the statement of the owner. A considerably larger number of living scale insects occurred on these lower rows, which may possibly be due to the fact that these trees were somewhat more infested in the spring; though this hardly seems an adequate explanation for the difference.

The extended breeding period of the San José scale was strikingly illustrated by finding a few living young and a great many in the white stage at the late date of Nov. 25. All the treated trees were then in a very thrifty condition and bore immense numbers of fruit buds.

Experiments at Warwick. The same mixture was applied Mar. 24 and 25 to some old peachtrees in the town of Warwick, Orange co. The mixture was prepared according to directions given above, and, owing to its not being very thick on some trees, a number were resprayed the second day. The applications in both instances were made on bright, rather sunshiny days, though there was some wind in the afternoon. Rain commenced to fall in a slight drizzle Friday afternoon, the 28th, and during the night it rained very hard. An examination the following morning showed that very little of the mixture had been washed off.

An examination of these trees July 8 showed little that was decisive. A few scales were living, and the same was true of untreated trees, and therefore no definite conclusions could be drawn. Fruit buds appeared not to have been affected by the application, and the trees did not seem to be harmed in the slightest.

An examination Nov. 24 failed to give anything decisive with this material. The trees sprayed with this substance were in as good condition as those treated with the crude petroleum or the whale oil soap solution, but the difference was not marked enough to warrant the drawing of any conclusions unless it be that the

lime, salt and sulfur proved fully as effective as the other insecticides under these unsatisfactory conditions.

The results obtained with the lime, salt and sulfur mixture seem to indicate that, in order to be effective, the wash must not be exposed to drenching rains within three or four days after application. The exceedingly poor results following the application in the vicinity of Albany apparently show that this material is nearly worthless if the application be followed immediately by considerable rain. This instance certainly raises a strong doubt as to the value of this material when applied under such conditions. Should subsequent experiments prove this to be true, it will nearly disqualify this wash for use in our eastern climate, since such periods of immunity from rain can not be depended on in early spring, and the same is true to a lesser extent in the fall and during the winter.

Summary

Our experience during the past three years and that of many others with spring applications of crude petroleum emulsion has been so uniformly satisfactory that we are at loss to account for the poor results obtained by others. The many injuries to fruit trees and the dangerous nature of the material emphasize the necessity of caution and the grower, who would use crude petroleum is therefore advised to experiment on a small scale at first. The fall treatment came so near injuring the trees that we can not advise it. The application of this material in successive years has not caused the injury we feared but on the contrary the trees have grown rapidly and gained in vigor.

The whale oil soap is a valuable insecticide, particularly when applied in the fall though in doing this there is danger of injuring peach buds. A spring application, using only 1¼ lb to the gallon, if thorough, is a very effective check.

Our experience with lime, salt and sulfur has not been entirely satisfactory but the many excellent reports from other experimenters lead us to believe that possibly our results may have been exceptional and that this mixture may prove a most excellent material for controlling this scale insect, a point which can be determined only by further experimentation. It is, however, very disagreeable to handle, being hard on operator and apparatus.

VOLUNTARY ENTOMOLOGIC SERVICE OF NEW YORK STATE

The work of the last three years has been continued, and a number of observations have been added to previous records. The exceedingly unfavorable season, as noted on the preceding page has interfered with the reception of the usual number of reports. Thirty voluntary observers were appointed during the season, and but 19 of them rendered reports. This is largely due to the general scarcity of injurious insects, which led a number of observers to conclude that there was comparatively little worthy of record. It will be noted that the following reports contain a considerable number of negative statements. These are of value as emphasizing observations on the marked scarcity of different species. The almost universal comments on cold, unseasonable weather seem to warrant the conclusion that the relative absence of insect life was due to adverse climatic conditions.

Summaries of reports from voluntary observers

The scientific names, or other matter, inserted in brackets indicate determinations or information supplied by the entomologist, and the other names are presumably correct except where questioned. The date given after the record is that of the writing of the record, except in a few instances where this was absent, and the date of reception was inserted. The latter is from one to two days later than that of the original record.

Cattaraugus county (C. E. Eldredge, Leon)—Appletree tent caterpillars [Clisiocampa americana Fabr.] appeared May 23, and the appletree bark louse [Mytilaspis pomorum Bouché] is quite abundant on some trees. A few years ago bumblebees were very abundant in this section, but now we seldom see them. May 28. Colorado potato beetles [Doryphora 10-lineata Say] appeared May 31. The looper caterpillar has been very abundant on beech and mapletrees. A few specimens of the cottony mapletree scale insect [Pulvinaria innumerabilis Rathv.] have appeared on maples, and another scale (Lecanium ? quercitronis) was found on ironwood leaves that had withered on the branch. A specimen of the larva of Notolophus ? antiqua Linn. was found on

an appletree. Cankerworms have also appeared. June 11. The cottony maple tree scale insect has increased largely in numbers in the last few weeks. Colorado potato beetles are doing very little damage this summer. This is probably due to the excessive wet weather, which has also prevented grasshopper eggs from hatching. Only three or four nests of the appletree tent caterpillar have been met with. Flies are quite numerous on cattle [probably the horn fly ? Haematobia serrata Robs. Desv.], and the wet weather does not seem to affect them much. The codling moth [Carpocapsa pomonella Linn.] has damaged the apple crop to quite an extent. July 22. Fall webworms [Hyphantria textor Harris] appeared on our apple and forest trees the last week of July. Grasshoppers are quite abundant in some sections, and squash bugs are not as numerous as last year. The excessive wet weather has prevented serious injuries by grasshoppers, though they have worked on heads of grain to a considerable extent. Aug. 12.

Chemung county (M. H. Beckwith, Elmira)—The currant sawfly [Pteronus ribesii Scop.] appeared on gooseberries May 2, though not in such large numbers as usual. Appletree tent-caterpillars [Clisiocampa americana Fabr.] are very abundant again this season. Colorado potato beetles [Doryphora 10-lineata Say] are not found in any numbers at the present date. The excessively cold weather appears to be holding insects in check to a great extent. May 28. The second brood of the currant sawfly has appeared on the leaves, though it is not usually found till the fruit is nearly ripe. Cutworms are very abundant in tobacco fields and are necessitating a large amount of resetting of plants where they have been destroyed. June 16. Potato beetles are not so abundant as last year, and the larvae or grubs appear to have been held in check by the unusually cold, wet weather. The same appears to have been true of most of our destructive insects, though grasshoppers are quite numerous in meadows and pastures. July 17.

Dutchess county (H. D. Lewis, Annandale)—Injurious insects have been unusually scarce up to date. Colorado potato beetles [Doryphora 10-lineata Say] are present in small numbers, and no elm leaf beetles [Galerucella luteola Müll.] have

been observed where in former years trees were defoliated by them. Though the forest tent caterpillars [Clisiocampa disstria Hübn.] have been numerous, they have not been so abundant as last year, and they are now in the pupa or cocoon stage. Some maples have been badly defoliated by this pest. June 20. Aside from the forest tent caterpillar, we have been remarkably free from insect pests. These caterpillars have inflicted considerable damage on hard maples, our principal shade trees. June 23. A few elm leaf beetles have made their appearance, though but little damage has been caused. The extremely wet weather has kept insects pretty well in check. Potato beetles have been scarce and easily controlled. July 18.

Erie county (J. U. Metz, Sowormville)—Asparagus beetles [Crioceris asparagi Linn.] have been exceedingly numerous this spring and much more abundant than in former years. No currant worms [Pteronus ribesii Scop.] have appeared so far and few potato beetles. A very little Hessian fly [Cecidomyia destructor Say] has been observed in a neighboring wheat field. May 28. Hessian fly has been found only in very small numbers; probably less than 1% of wheat is infested. There appears to be no more of this pest on no. 6 wheat than on more resistant varieties. The bud moth [Tmetocera ocellana Schiff.] is scarce, and no indications of the palmer worm [Ypsolophus pometellus Harr.] have been observed. Not a single nest of the appletree tent caterpillar [Clisiocampa americana Fabr.] has been found. June 20.

Genesee county (J. F. Rose, South Byron)—The first asparagus beetle [Crioceris asparagi Linn.] was observed May 25, and the currant sawfly [Pteronus ribesii Scop.] had lopped young currant shoots by May 23. There is a little complaint of potato beetles [Doryphora 10-lineata Say] working on tomatoes. No injury by Hessian fly [Cecidomyia destructor Say] has been reported, and appletree tent caterpillars [Clisiocampa americana Fabr.] do not appear to be as abundant as last year. Currant worms are rarer. May 26. Appletree tent caterpillars are certainly much less numerous than last year. There are not nearly so many to be seen along the roadsides, and their scarcity in these places is attributed to the

mice girdling most of the wild cherries the previous winter. The young caterpillars, therefore, had nothing to feed on and died. May beetles [Lachnosterna species] are very numerous in the soil. June 2. Potato beetles are very abundant on early potatoes. But little damage has as yet been reported from the Hessian fly. There does not appear to be one appletree tent caterpillar this year where there were a hundred last year. The weather has been very cool and dry. The bud moth [Tmetocera ocellana Schiff.] has been very abundant and is apparently becoming more numerous each year. It is one of our worst fruit pests. June 10. Striped cucumber beetles [Diabrotica vittata Fabr.] were first observed June 14. There are yet no reports of injuries by the Hessian fly, and not a tree has been seen that was troubled by the forest tent caterpillar [Clisiocampa disstria Hübn.], even where the pest was abundant last year. June 16. The black squash bug, or stink bug [Anasa tristis DeGeer], appeared June 21. They are few as compared with the striped cucumber beetle. The very wet, cold weather appears to have delayed the appearance of many insect pests, including the Hessian fly. Even the white wheat, no. 6, that was so badly injured last year, is comparatively free from damage the present season. June 25. The first nests of the fall webworm [Hyphantria textor Harris] were observed July 22, and the spotted grapevine beetle [Pelidnota punctata Linn.] and the squash vine borer [Melittia satyriniformis Hübn.] had also appeared by that time. The striped cucumber beetle and the squash bug are much less abundant than last year. The green cabbage worms [Pieris rapae Linn.] are becoming quite numerous. Mosquitos were very scarce in this vicinity till last week. The Colorado potato beetle [Doryphora 10-lineata Say] has been as bad, if not worse, than ever before in some sections. Many growers have been obliged to resort to power sprayers in order to control the pest. July 28. The fall webworm is by far the most abundant I have ever seen it. A hairy caterpillar [Datana integerrima Gr. & Rob.] has defoliated some of the butternut and black walnut trees in this section. The squash bug is much less abundant than it has been for a number of years. Sep. 1.

Greene county (O. Q. Flint, Athens)—The forest tent caterpillar [Clisiocampa disstria Hübn.] appears to be carrying its destructive work eastward, leaving infested territory after two to four years' depredations. June 25.

Herkimer county (George S. Graves, Newport)—The currant sawfly [Pteronus ribesii Scop.] was observed on bushes May 23 and had evidently been feeding for about a week. Pistol case-bearers [Coleophora malivorella Riley] are abundant in some orchards, while the appletree tent caterpillar [Clisiocampa americana Fabr.] is relatively scarce as yet. The currant aphis [Myzus ribis Linn.] is not very plentiful, though it appeared shortly after the currant leaves. Bumblebees are very abundant this season. May 29. The Colorado potato beetle [Doryphora 10-lineata Say] appeared May 31, and farmers report it as being unusually abundant. Plantain leaves have been eaten by the same insect [probably Dibolia borealis Chev.], as for the last three years. The striped cucumber beetle [Diabrotica vittata Fabr.] was recently found on potato vines in my garden, and a neighbor reports a large number of them on his potatoes. The larvae of the elm flea beetle [Disonycha triangularis Say] appears to be quite injurious to elms throughout this section, and signs of their work were observed in the city of Utica. Grasshoppers are not very abundant as yet. June 12. The spiny elm caterpillar [Euvanessa antiopa Linn.] has been feeding on alders to a considerable extent. The eggs of the praying mantis [Mantis religiosa Linn.] appear to be hatching. June 22. The first grubs of the Colorado potato beetle were observed June 23. The forest tent caterpillar [Clisiocampa disstria Hübn.] is extremely rare, but one larva having been observed this year, though it is reported as being very abundant at Gravesville, 7 miles north. Grasshoppers are not numerous. The cold weather seems to have checked the development of many insects. The spiny elm caterpillars are devouring the foliage of wayside bushes. June 27. Rose beetles [Macrodactylus subspinosus Fabr.] have been and are still very destructive to plants in the local cemetery. Besides depredating on hydrangeas and rosebushes, they have nearly defoliated a large Virginia creeper and are now working on the lower leaves of a large elm tree.

They have also attacked geraniums in the cemetery and later cherry and plum trees to some extent. The foliage of one raspberry bush has been nearly destroyed by these pests. July 4. Rose beetles have been exceedingly destructive in this section and seem to attack almost everything in the vegetable line this season. The black headed cabbage worm [Evergestis stramenalis Hübn.] is causing much damage to turnips. Currant worms have again made their appearance and seem to be a fourth brood. Horn flies [Haematobia serrata Rob.-Desv.] are not so abundant as usual. Grasshoppers are eating potato vines seriously, while the Colorado potato beetle is somewhat scarce. July 21. Spittle insects were noticed on a small butternut tree in the woods July 17. Horn flies have been plentiful for about a week, and the large horseflies, usually so common during haying time, are just appearing, Aug. 1. The first nest of the fall webworm [Hyphantria textor Harris] was noticed on cherry Aug. 1. Rose beetles, though they have been very destructive to nearly every plant, have not eaten the small plants as they did last year. Caterpillars of the cabbage butterfly [Pieris rapae Linn.] have begun their depredations. Rainy weather continues to keep many destructive insects in check. Aug. 2. Caterpillars of the cabbage butterfly are more abundant than I have ever known them, while the adult insects are correspondingly scarce, having been seldom seen about the garden. Aug. 18. Cabbage butterflies were very numerous Aug. 21, and currant worms were noticed within a week on currant bushes. Sep. 16.

Livingston county (W. R. Houston, Geneseo)—Four lined leaf bugs [Poecilocapsus lineatus Fabr.] are now working on currants. This week has been very cold, and the temperature is between 36° and 40°, with snow flurries. May 28. Market gardeners in this vicinity are complaining of injuries by the cabbage root maggot [Phorbia brassicae Bouché], and they are afraid that the crop will be a short one. There was a heavy white frost on the 9th. Colorado potato beetles [Doryphora 10-lineata Say] are few, and so far no eggs have hatched. June 12.

Ontario county (J. J. Barden, Stanley)—Cutworms are very abundant and are doing a great deal of damage in newly set

cabbage fields. One farmer reports a loss of 6000 plants on three acres. The complaint is very general in this section. June 20. A webworm [? Tetralopha] is very abundant on maple, elm and other forest trees in the vicinity of Dansville, though not so numerous as last year. Sep. 20.

Orange county (J. M. Dolph, Port Jervis)—Very few injurious insects have appeared this year. Even plant lice are relatively scarce; and the appletree tent caterpillar [Clisiocampa americana Fabr.] has almost entirely disappeared. There has been comparative freedom from insect pests this year, which may possibly be attributed to the cold, wet weather. The average temperature in this section for July and August 1901 was 74.2° while the average for the same months this year was 69.2°, a decrease during the past season of 5°. Sep. 3.

Queens county (C. L. Allen, Floral Park)—Colorado potato beetles [Doryphora 10-lineata Say] have been conspicuous by their absence, and not one farmer in ten has had occasion to use paris green for the purpose of controlling them. Not a cabbage worm [Pieris rapae Linn.] has been seen. The heavy rains of April killed all the butterflies, and now we see only one or two. The season has been marked by an almost entire absence of the more common insect pests. Oct. 3.

Rensselaer county (W. C. Hitchcock, Pittstown)—The appletree tent caterpillars [Clisiocampa americana Fabr.] are abundant and very destructive, since the foliage is backward and their ravages are more apparent. They do not seem to have been injured in the slightest by the late frost. Plum curculio [Conotrachelus nenuphar Herbst.] pupae are unusually abundant in the soil about the trees. May 23. Asparagus beetles [Crioceris asparagi Linn.] are abundant. Apples are nearly all dropping on account of the worms. [Probably the codling moth larva, Carpocapsa pomonella Linn.] Aug. 13. One mantis [Mantis religiosa Linn.] was found nearly grown on Sep. 28, and a neighbor who saw it stated that she had observed several of them. Sep. 30.

Rockland county (S. B. Huested, Blauvelt)—The corn worm [Chelymorpha argus Licht.] appears to be doing considerable damage. The fall webworm [Hyphantria textor Harris] is quite plentiful in this section. Colorado potato beetles

[Doryphora 10-lineata Say] have not been so abundant as in former years, which is probably due to the cooler season. Plum curculios [Conotrachelus nenuphar Herbst.] are plenty, but not so prevalent as during some seasons. July 12.

Schoharie county (John F. Johnson, Breakabeen)—Currant worms [Pteronus ribesii Scop.] appeared May 20 and are quite abundant and destructive. The grubs of the May or June beetle are also numerous and somewhat injurious. No forest tent caterpillars [Clisiocampa disstria Hübn.] have been observed this season, and those belonging to the appletree species [Clisiocampa americana Fabr.] are spinning their cocoons. May. 30. Colorado potato beetles [Doryphora 10-lineata Say] appeared about June 1 and are quite abundant. A very few forest tent caterpillars were observed and they are now spinning their cocoons. June 15.

Suffolk county (Alexander Mair, Oakdale)—There are very few Colorado potato beetles [Doryphora 10-lineata Say] in Suffolk county this year. Locusts [? Cicada septendecim Linn.] are abundant, but appear to be doing no special injury. The San José scale [Aspidiotus perniciosus Comst.] is very bad in this section, and comparatively little is being done toward its control. There are too many remedies and faith in none. June 23.

Tompkins county (C. E. Chapman, Peruville)—Forest tent caterpillars [Clisiocampa disstria Hübn.] have damaged a few maple and apple trees. The striped cucumber beetle [Diabrotica vittata Fabr.] is present in marked numbers, and the Colorado potato beetles [Doryphora 10-lineata Say] are scarce for this time of year. Flea beetles [? Epitrix cucumeris Harris] are very abundant, completely riddling potatoes, red raspberries and other foliage. June 30. Cabbage worms [Pieris rapae Linn.] are abundant and easily killed with paris green and water. Potato beetles are not numerous, though white grubs are plenty in potato fields and newly set strawberry beds. There is an abundance of young grasshoppers. July 30.

Ulster county (George S. Clark, Milton)—Some plant lice [? Myzus cerasi Fabr.] have appeared on cherrytrees and the appletree tent caterpillar [Clisiocampa americana Fabr.]

has done considerable damage in this section. There are hundreds of its nests in defoliated wild cherry and appletrees. May 30. The grape leaf curler [probably the grapevine plume moth, Oxyptilus periscelidactylus Fitch] appeared May 25. Appletree tent caterpillars are very abundant and are making their cocoons in large numbers. There are very few leaf hoppers [?Typhlocyba] on grapes. Plant lice are increasing in numbers, and thrips are abundant on rosebushes. June 15. Comparatively few insects are causing injury at the present time. The black flea beetle [Epitrix cucumeris Harris] is doing considerable damage to tomato and potato vines. June 13. Nests of the fall webworm [Hyphantria textor Harris] have begun to appear, and there are a few plant lice on cherry-trees. July 3. The second brood of currant worms [Pteronus ribesii Scop.] has appeared on some unsprayed bushes. Fall webworms are increasing in numbers, and they can be seen in many trees. Colorado potato beetles [Doryphora 10-lineata Say] are causing some injury, though they are not very numerous. July 10. Leaf hoppers are very scarce on grapevines and rosebushes. The continuous wet, cold weather appears to have kept them in check. Only a few fall webworms are to be seen at the present time. July 31. Fall webworms are still present but not nearly so abundant as last year, there being not over one nest to 25 of last season. There are some cabbage worms [Pieris rapae Linn.], but, as cabbage is little grown in this section, not much damage has been done. Aug. 27.

Warren county (C. L. Williams, Glens Falls)—Strawberry sawflies [Monostegia ignota Nort.] are feeding to some extent on strawberry plants. June 5. There are no insects in this region causing special trouble. July 29.

Wyoming county (W. H. Roeper, Wyoming)—Cankerworms made their appearance May 22 and have caused very little damage as yet. Appletree tent caterpillars [Clisiocampa americana Fabr.] are scarce, and very few of the forest species [Clisiocampa disstria Hübn.] have been found. May 26. The weather has been cold and wet since Saturday, and there was a white frost Sunday night. This unseasonable weather appears to have kept insects pretty well in check, and there is comparatively little to report. June 10.

FAUNAL STUDIES

A detailed study of the distribution of insects in New York State, or, for that matter, in any section where there is some variety in climate and physical characteristics, is bound to result in some interesting discoveries regarding the factors limiting the presence of various species. This is a matter of considerable importance, since it has a practical application in enabling us to determine in a measure the limits beyond which some of our very destructive, introduced species can not spread. The collection of my assistant, Mr Young, listed below, has been made in an exceptionally rich locality, where there is more or less mingling of boreal and austral forms. Over 700 species are represented in the list, to which we expect large additions will be made in the future. It is published at this time, not only to make the data available, but also in the hopes that other entomologists in that locality may be encouraged to continue the work.

LIST OF COLEOPTERA TAKEN AT NEWPORT, HERKIMER CO. N. Y.

BY D. B. YOUNG

We have had lists from the western and southeastern parts of the State of New York and the Adirondacks, but none so far, to our knowledge, from the central portion of the State. The object of this list is threefold. partially to fill the gap, to call the attention of collectors and others to a much neglected field, and to show the result of five years' continuous collecting in a single restricted locality, restricted in that this section is almost destitute of pine, spruce, balsam and oak. Therefore, it will be noticed that many of the forms found about these trees, only a day's drive to the north, are absent from this list.

Our thanks are due to Mr Charles Liebeck of Philadelphia Pa. for his kindness in determining quite a large number of the beetles.

COLEOPTERA.

Cicindela 6-guttata *Fabr.*
C. purpurea *Oliv.*
C. vulgaris *Say*
C. repanda *Dej.*
Omophron tesselatum *Say*
Cychrus brevoorti *Lec.*
C. lecontei *Dej.*
Carabus maeander *Fisch.*
C. limbatus *Say*
Calosoma scrutator *Fabr.*
C. frigidum *Kirby*
C. calidum *Fabr.*
Elaphrus ruscarius *Say*
Dyschirius *sp.*
Clivina impressifrons *Lec.*
Schizogenius amphibius *Hald.*
Bembidium inaequale *Say*
B. nigrum *Say*
B. ustulatum *Linn.*
B. picipes *Kirby*
B. variegatum *Say*
B. intermedium *Kirby*
B. versicolor *Lec.*
B. quadrimaculatum *Linn.*
Tachys laevus *Say*
T. nanus *Gyll.*
T. flavicauda *Say*
T. tripunctatus *Say*
Patrobus longicornis *Say*
Pterostichus adoxus *Say*
P. rostratus *Newm.*
P. honestus *Say*
P. lucublandus *Say*
Amara fallax *Lec.*
A. interstitialis *Dej.*
A. obesa *Say*
Dicaelus elongatus *Bon.*
Calathus gregarius *Say*
Platynus hypolithus *Say*
P. angustatus *Dej.*
P. sinuatus *Dej.*
P. melanarius *Dej.*
P. cupripennis *Say*
P. placidus *Say*
P. ruficornis *Lec.*
P. picipennis *Kirby*
Galerita janus *Fabr.*
Lebia grandis *Hentz.*
L. ornata *Say*
Lebia fuscata *Dej.*
L. scapularis *Dej.*
Apristus cordicollis *Leo.*
Cymindis pilosa *Say*
Brachynus fumans *Fabr.*
B. cordicollis *Dej.*
Chlaenius sericeus *Forst.*
C. tricolor *Dej.*
C. pennsylvanicus *Say*
Brachylobus lithophilus *Say*
Geopinus incrassatus *Dej*
Agonoderus pallipes *Fabr.*
A. partiarius *Say*
A. pauperculus *Dej.*
A. testaceus *Dej.*
Harpalus viridiaeneus *Beauv.*
H. caliginosus *Fabr.*
H. pennsylvanicus *De G.*
H. *var.* erythropus *Dej.*
H. herbivagus *Say*
Bradycellus rupestris *Say*
Anisodactylus nigerrimus *Dej*
A. verticalis *Lec.*
Haliplus ruficollis *De G.*
Cnemidotus 12-punctatus *Say*
C. edentulus *Lec.*
Laccophilus maculosus *Germ.*
Bidessus affinis *Say*
Coelambus punctatus *Say*
Hydroporus modestus *Aubé*
Ilybius biguttalus *Germ.*
Copelatus glyphicus *Say*
Agabus obtusatus *Say*
Rhantus binotatus *Harris*
Colymbetes sculptilis *Harris*
Dytiscus fasciventris *Say*
D. verticalis *Say*
Acilius semisulcatus *Aubé*
A. fraternus *Harris*
Gyrinus ventralis *Kirby*
Dineutes assimilis *Aubé*
Helophorus lineatus *Say*
Hydrochus excavatus *Lec.*
H. subcupreus *Rand.*
Hydrophilus triangularis *Say*
H. nimbatus *Say*
H. glaber *Herbst*
Hydrocharis obtusatus *Say*
Berosus striatus *Say*

Laccobius agilis *Rand.*
Philhydrus ochraceus *Melsh.*
Hydrocombus fimbriatus *Melsh.*
Hydrobius globosus *Say*
H. fuscipes *Linn.*
H. digestus *Lec.*
Sphaeridium scarabaeoides *Linn.*
Cercyon praetextatum *Say*
C. unipunctatum *Linn.*
Cryptopleurum vagans *Lec.*
Necrophorus orbicollis *Say*
N. marginatus *Fabr.*
N. pustulatus *Hersch.*
N. vespilloides *Herbst*
N. tomentosus *Web.*
Silpha surinamensis *Fabr.*
S. lapponica *Herbst*
S. inaequalis *Fabr.*
S. noveboracensis *Forst.*
S. americana *Linn.*
Choleva luridipennis *Mann.*
C. simplex *Say*
C. clavicornis *Lec.*
C. terminans *Lec.*
Prionochaeta opaca *Say*
Anisotoma collaris *Lec.*
Colenis impunctata *Lec.*
Liodes globosa *Lec.*
L. basalis *Lec.*
Agathidium oniscoides *Beauv.*
A. politum *Lec.*
Tmesiphorus carinatus *Say*
Tyrus humeralis *Aubé*
Falagria cingulata *Lec.*
Aleochara lata *Grav.*
A. bimaculata *Grav.*
Gyrophaena affinis *Fauv.*
Quedius fulgidus *Fabr.*
Q. capucinus *Grav.*
Listotrophus cingulatus *Grav.*
L. capitatus *Bland.*
Creophilus villosus *Grav.*
Staphylinus maculosus *Grav*
S. violaceus *Grav.*
Ocypus ater *Grav.*
Philonthus aeneus *Rossi*
P. lomatus *Er.*
P. brunneus *Grav.*
P. cyanipennis *Fabr.*
P. blandus *Grav.*
Actobius sobrinus *Er.*
A. paederoides *Lec.*
A. terminalis *Lec.*
Xantholinus cephalus *Say*
Leptolinus rubripennis *Lec.*
Stenus bipunctatus *Er.*
S. juno *Fabr.*
S. stygicus *Say*
S. parallelus *Casey*
S. flavicornis *Er.*
S. canadensis *Casey*
S. punctatus *Er.*
Cryptobium bicolor *Grav.*
C. pallipes *Grav.*
Lathrobium punctulatum *Lec.*
L. bicolor *Lec.*
L. collare *Er.*
Paederus littorarius *Grav.*
Sunius longiusculus *Mann.*
Tachinus memnonius *Grav.*
T. addendus *Horn*
T. flavipennis *Dej.*
T. fimbriatus *Grav.*
T. picipes *Er.*
T. limbatus *Melsh.*
Tachyporus maculipennis *Lec.*
T. jocosus *Say*
T. chrysomelinus *Linn.*
Conosoma littoreum *Linn.*
C. crassum *Grav.*
C. pubescens *Payk.*
C. basale *Er.*
C. scriptum *Horn*
Boletobius niger *Grav.*
B. cingulatus *Mann.*
B. cincticollis *Say*
B. anticus *Horn*
B. trinotatus *Er.*
B. cinctus *Grav.*
B. quaesitor *Horn*
Mycetoporus americanus *Er.*
Oxyporus femoralis *Grav.*
O. lateralis *Grav.*
O. 5-maculatus *Lec.*
Oxytelus sculptus *Grav.*
O. rugosus *Grav.*
O. fuscipennis *Mann.*
Anthobium convexum *Fauv.*
Glyptoma costale *Er.*
Siagonium punctatum *Lec.*

Actidium *sp.*
Ptenidium *sp.*
Trichopteryx haldemanni *Lec.*
Scaphidium quadriguttatum *Say*
Scaphisoma convexum *Say*
Olibrus consimilis *Marsh*
Sacium fasciatum *Say*
Megilla maculata *De G.*
Hippodamia glacialis *Fabr.*
H. convergens *Guér.*
H. 13-punctata *Linn.*
H. parenthesis *Say*
Coccinella trifasciata *Linn.*
C. 9-notata *Herbst*
C. transversoguttata *Fabr.*
C. *var.* californica *Mann.*
C. sanguinea *Linn.*
Adalia bipunctata *Linn.*
Anatis 15-punctata *Oliv.*
Psyllobora 20-maculata *Say*
Chilocorus bivulnerus *Muls.*
Brachyacantha ursina *Fabr.*
B. *var.* 10-pustulata *Melsh.*
B. 4-punctata *Melsh.*
Hyperaspis undulata *Say*
H. signata *Oliv.*
Scymnus collaris *Melsh.*
S. tenebrosus *Muls.*
Rhanis unicolor *Ziegl.*
Phymaphora pulchella *Newm.*
Aphorista vittata *Fabr.*
Mycetina perpulchra *Newm.*
Endomychus biguttatus *Say*
Languria mozardi *Lat.*
L. gracilis *Newm.*
Dacne maculata *Say*
Megalodacne fasciata *Fabr.*
M. heros *Say*
Mycotretus sanguinipennis *Say*
M. pulchra *Say*
Tritoma festiva *Lec.*
T. macra *Lec.*
T. thoracica *Say*
Synchita fuliginosa *Melsh.*
Ditoma quadriguttata *Say*
Cerylon castaneum *Say*
Philothermus glabriculus *Lec.*
Rhyssodes exaratus *Ill.*
Silvanus surinamensis *Linn.*
S. bidentatus *Fabr.*
Silvanus imbellis *Lec.*
S. advena *Waltl.*
Catogenus rufus *Fabr.*
Cucujus clavipes *Fabr.*
Laemophlaeus biguttatus *Say*
L. fasciatus *Melsh.*
L. modestus *Say*
L. convexulus *Lec.*
L. adustus *Lec.*
L. testaceus *Fabr.*
Dendrophagus glaber *Lec.*
Uliota dubius *Fabr.*
Atomaria ochracea *Zimm.*
A. ephippiata *Zimm.*
Ephistemus apicalis *Lec.*
Mycetophagus punctatus *Say*
M. flexuosus *Say*
M. bipustulatus *Melsh.*
M. pluripunctatus *Lec.*
M. obsoletus *Melsh.*
Tryphyllus humeralis *Kirby*
Typhoea fumata *Linn.*
Byturus unicolor *Say*
Dermestes caninus *Germ.*
D. lardarius *Linn.*
D. vulpinus *Fabr.*
Attagenus piceus *Oliv.*
Trogoderma ornatum *Say*
T. tarsale *Melsh.*
Anthrenus scrophulariae *Linn.*
A. varius *Fabr.*
A. musaeorum *Linn.*
Hister interruptus *Beauv.*
H. americanus *Payk.*
H. lecontei *Mars.*
H. gracilis *Lec.*
Epierus regularis *Beauv.*
Saprinus rotundatus *Kug.*
S. assimilis *Payk.*
S. fraternus *Say*
S. patruelis *Lec.*
Plegaderus transversus *Say*
Bacanius punctiformis *Lec.*
Brachypterus urticae *Fabr.*
Cercus abdominalis *Er.*
C. pennatus *Murr.*
Carpophilus niger *Say*
C. brachypterus *Say*
Colastus truncatus *Rand.*
Conotelus obscurus *Er.*

Epuraea rufa *Say*
Nitidula bipustulata *Linn.*
N. rufipes *Linn.*
Phenolia grossa *Fabr.*
Omosita colon *Linn.*
Thalycra concolor *Lec.*
Perthalycra murrayi *Horn*
Orthopeplus quadricollis *Horn*
Cychramus adustus *Er.*
Cryptarcha ampla *Er.*
Ips quadriguttata *Fabr.*
I. sanguinolentus *Oliv.*
I. confluentus *Say*
I. vittatus *Say*
Rhizophagus dimidiatus *Mann.*
R. bipunctatus *Say*
R. remotus *Lec.*
Latridius minutus *Linn.*
Corticaria grossa *Lec.*
Tenebrioides corticalis *Melsh.*
T. castanea *Melsh.*
Peltis pippingskoeldi *Mann.*
Calitys scabra *Thunb.*
Grynocharis 4-lineata *Melsh.*
Thymalus fulgidus *Er.*
Bactridium ephippigerum *Guér.*
B. striolatum *Reit.*
B. cavicolle *Horn*
Cytilus sericeus *Forst.*
Heterocerus fatuus *Kies.*
Ptilodactyla serricollis *Say*
Ectopria nervosa *Melsh.*
Prionocyphon discoideus *Say*
Cyphon obscurus *Guér.*
C. collaris *Guér.*
C. variabilis *Thunb.*
Tharops ruficornis *Say*
Deltometopus amoenicornis *Say*
Dromaeolus cylindricollis *Say*
D. striatus *Lec.*
Fornax orchesides *Newm.*
Microrrhagus humeralis *Say*
M. pectinatus *Lec.*
Epiphanis cornutus *Esch.*
Adelocera marmorata *Fabr.*
A. aurorata *Lec.*
A. brevicornis *Lec.*
Alaus oculatus *Linn.*
Cryptohypnus planatus *Lec.*
C. abbreviatus *Say*
Cryptohypnus bicolor *Esch.*
C. tumescens *Lec.*
C. pectoralis *Say*
C. *var.* inops *Lec.*
C. melsheimeri *Horn*
Elater hepaticus *Melsh.*
E. pedalis *Germ.*
E. nigricollis *Herbst*
E. linteus *Say*
E. vitiosus *Lec.*
E. semicinctus *Rand.*
E. obliquus *Say*
Drasterius elegans *Fabr.*
Agriotes mancus *Say*
A. fucosus *Lec.*
Dolopius lateralis *Esch.*
Melanotus castanipes *Payk.*
M. fissilis *Say*
M. communis *Gyll.*
Limonius plebejus *Say*
Campylus denticornis *Kirby*
Pityobius anguinus *Lec.*
Athous cucullatus *Say*
A. rufifrons *Rand.*
Sericosomus silaceus *Say*
Corymbites vernalis *Hentz.*
C. cylindriformis *Herbst*
C. spinosus *Lec.*
C. sulcicollis *Say*
C. hamatus *Say*
C. hieroglyphicus *Say*
C. cruciatus *Linn.*
Asaphes decoloratus *Say*
A. memnonius *Herbst*
Throscus constrictor *Say*
T. convergens *Horn*
Dicerca divaricata *Say*
D. obscura *Fabr.*
D. *var.* lurida *Fabr.*
Buprestis maculiventris *Say*
Melanophila longipes *Say*
M. fulvoguttata *Harris*
Anthaxia viridicornis *Say*
Chrysobothris femorata *Fabr.*
Agrilus ruficollis *Fabr.*
A. otiosus *Say*
A. bilineatus *Web.*
Agrilus politus *Say*
Brachys ovata *Web.*

Brachys aerosa *Melsh.*
Calopteron reticulatum *Fabr.*
Celetes basalis *Lec.*
Cacnia dimidiata *Fabr.*
Lopheros fraternus *Rand.*
Eros thoracicus *Rand.*
E. aurora *Herbst*
E. sculptilis *Say*
E. crenatus *Germ.*
Plateros canaliculatus *Say*
P. lictor *Newm.*
Polyclasis bifaria *Say*
Lucidota atra *Fabr.*
L. punctata *Lec.*
Ellychnia corrusca *Linn.*
Pyropyga fenestralis *Melsh.*
P. decipiens *Harris*
Pyractomena lucifera *Melsh.*
Photinus ardens *Lec.*
P. scintillans *Say*
Photuris pennsylvanica *De G.*
Chauliognathus pennsylvanicus *De G.*
Podabrus tricostatus *Say*
P. rugulosus *Lec.*
P. basilaris *Say*
P. comes *Lec.*
P. punctatus *Lec.*
P. pattoni *Lec.*
Telephorus dentiger *Lec.*
T. excavatus *Lec.*
T. carolinus *Fabr.*
T. lincola *Fabr.*
T. scitulus *Say*
T. rectus *Melsh.*
T. pusillus *Lec.*
T. rotundicollis *Say*
T. tuberculatus *Lec.*
T. bilineatus *Say*
Ditemnus bidentatus *Say*
Malthodes arcifer *Lec.*
M. fuliginosus *Lec.*
Collops 4-maculatus *Fabr.*
Cymatodera bicolor *Say*
Clerus quadriguttatus *Oliv.*
Thaneroclerus sanguineus *Say*
Hydnocera longicollis *Ziegl.*
Necrobia violaceus *Linn.*
Ptinus fur *Linn*
P. quadrimaculatus *Melsh.*
Trypopitys sericeus *Say*
Ptilinus ruficornis *Say*
Endecatomus rugosus *Rand.*
Cupes concolor *Westw.*
C. capitata *Fabr.*
Cis fuscipes *Mellié*
Ennearthron thoracicornis *Ziegl.*
Ceracis sallei *Mellié*
Dorcus parallelus *Say*
Platycerus quercus *Web.*
Ceruchus piceus *Web.*
Passalus cornutus *Fabr.*
Copris anaglypticus *Say*
Onthophagus hecate *Panz.*
Aegialia rufa *Lec.*
Ataenius gracilis *Melsh.*
A. cognatus *Lec.*
Dialytes striatulus *Say*
Aphodius fossor *Linn.*
A. fimetarius *Linn.*
A. granarius *Linn.*
A. inquinatus *Herbst*
A. stercorosus *Melsh.*
A. prodromus *Brahm.*
A. walshii *Horn*
Bolboceras lazarus *Fabr.*
Odontaeus cornigerus *Melsh.*
Geotrupes splendidus *Fabr.*
G. egeriei *Germ.*
G. balyi *Jek.*
Trox suberosus *Fabr.*
T. tuberculatus *De G.*
T. scaber *Linn.*
Dichelonycha elongata *Fabr*
D. testacea *Kirby*
Serica vespertina *Gyll.*
S. sericea *Ill.*
Macrodactylus subspinosus *Fabr.*
Lachnosterna fusca *Fröhl.*
Pelidnota punctata *Linn.*
Euphoria inda *Linn.*
Cremastochilus canaliculatus *Kirby*
Osmoderma eremicola *Knoch*
O. scabra *Beauv.*
Trichius affinis *Gory*
T. viridulus *Fabr.*
Parandra brunnea *Fabr.*
Orthosoma brunneum *Forst.*
Prionus laticollis *Drury*
Tetropium cinnamopterum *Kirby*
Phymatodes variabilis *Fabr.*

Phymatodes infuscatus *Lec.*
P. dimidiatus *Kirby*
Callidium janthinum *Lec.*
Tylonotus bimaculatus *Hald.*
Molorchus bimaculatus *Say*
Plagionotus speciosus *Say*
Neoclytus erythrocephalus *Fabr.*
Clytanthus ruricola *Oliv.*
Cyrtophorus verrucosus *Oliv.*
Euderces picipes *Fabr.*
Desmocerus palliatus *Forst.*
Encyclops caeruleus *Say*
Centrodera decolorata *Harris*
Pachyta monticola *Rand.*
Anthophilax malachiticus *Lec.*
A. attenuatus *Hald.*
Acmaeops directa *Newm.*
Gaurotes cyanipennis *Say*
Typocerus velutinus *Oliv.*
Leptura lineola *Say*
L. haematites *Newm.*
L exigua *Newm.*
L. canadensis *Fabr.*
L. proxima *Say*
L. vittata *Germ.*
L. pubera *Say*
L. sphaericollis *Say*
L. vibex *Newm.*
L. aurata *Horn.*
L. mutabilis *Newm.*
Acanthoderes quadrigibbus *Say*
Leptostylus macula *Say*
Liopus alpha *Say*
Lepturges symmetricus *Hald.*
L. querci *Fitch*
Hyperplatys maculatus *Hald.*
Urographis fasciatus *De G.*
Pogonocherus mixtus *Hald.*
Saperda calcarata *Say*
S. vestita *Say*
S. tridentata *Oliv.*
Oberea bimaculata *Oliv.*
O. tripunctata *Swed.*
Tetraopes tetraophthalmus *Forst.*
Amphionycha flammata *Newm.*
Donacia rufa *Lec.*
Orsodachna atra *Ahr.*
Zeugophora varians *Cr.*
Syneta ferruginea *Germ.*
Lema trilineata *Oliv.*
Exema *sp.*
Bassareus mammifer *Newm.*
Cryptocephalus quadruplex *Newm.*
C. *var.* 4-guttulus *Suffr.*
C. mutabilis *Melsh.*
Pachybrachys litigiosus *Suffr.*
P. trinotatus *Melsh.*
P. intricatus *Suffr.*
Monachus saponatus *Fabr.*
Diachus auratus *Fabr.*
Xanthonia 10-notata *Say*
X. villosula *Melsh.*
Chrysochus auratus *Fabr.*
Typophorus canellus *Fabr.*
T. *var.* aterrimus *Oliv.*
T. *var.* thoracicus *Melsh.*
T. *var.* 6-notatus *Say*
Graphops pubescens *Melsh.*
Nodonota brunnea *Fabr.*
N. tristis *Oliv.*
Prasocuris vittata *Oliv.*
Doryphora clivicollis *Kirby*
D. 10-lineata *Say*
Chrysomela similis *Rog.*
C. praecelsis *Rog.*
C. elegans *Oliv.*
C. scalaris *Lec.*
C. philadelphica *Linn.*
C. *var.* spiraeae *Say*
C. multipunctata *Say*
Plagiodera viridis *Melsh.*
Gastroidea polygoni *Linn.*
Lina tremulae *Fabr.*
Cerotoma trifurcata *Forst.*
Phyllobrotica discoidea *Fabr.*
Luperus meraca *Say*
Diabrotica 12-punctata *Oliv.*
D. vittata *Fabr.*
D. longicornis *Say*
Trirhabda tomentosa *Linn. var.* canadensis *Kirby*
Galeruca decora *Say*
Oedionychis vians *Ill.*
O. quercata *Fabr. var.* limbalis *Melsh.*
Disonycha pennsylvanica *Ill.*
D. triangularis *Say*
D. xanthomelaena *Dalm.*
Haltica ignita *Ill.*
Crepidodera helxines *Linn.*
C. cucumeris *Harris*

Orthaltica copalina *Fabr.*
Systena hudsonias *Forst.*
S. marginalis *Ill.*
Phyllotreta vittata *Fabr.*
P. bipustulata *Fabr*
P. chalybeipennis *Cr.*
Dibolia borealis *Chev.*
Psylliodes punctulata *Melsh.*
Odontota nervosa *Panz.*
Coptocycla aurichalcea *Fabr.*
Chelymorpha argus *Licht.*
Bruchus pisi *Linn.*
Phellopsis obcordata *Kirby*
Nyctobates pennsylvanica *De G.*
Iphthimus opacus *Lec.*
Upis ceramboides *Linn.*
Haplandrus femoratus *Fabr.*
Scotobates calcaratus *Fabr.*
Xylopinus saperdioides *Oliv.*
Tenebrio molitor *Linn.*
T. tenebrioides *Beauv.*
Tribolium ferrugineum *Fabr.*
Uloma impressa *Melsh.*
Diaperis hydni *Fabr.*
Platydema excavatum *Say*
P. ruficorne *Sturm.*
P. flavipes *Fabr.*
P. americanum *Lap.*
Boletotherus bifurcus *Fabr.*
Boletophagus corticola *Say*
B. depressus *Rand.*
Cistela sericea *Say*
Mycetochares binotata *Say*
M. nigerrima *Casey*
Capnochroa fuliginosa *Melsh.*
Arthromacra aenea *Say*
Penthe obliquata *Fabr.*
P. pimelia *Fabr.*
Synchroa punctata *Newm.*
Prothalpia undata *Lec.*
Melandrya striata *Say*
Hypulus simulator *Newm.*
Dircaea liturata *Lec.*
Anisoxya glaucula *Lec.*
Eustrophus tomentosus *Say*
E. repandus *Horn*
Holostrophus bifasciatus *Say*
Hallomenus scapularis *Melsh.*
H. debilis *Lec.*
Orchesia castanea *Melsh.*
Orchesia gracilis *Melsh.*
Canifa pallipes *Melsh.*
Rhinosimus viridiaeneus *Rand*
Asclera ruficollis *Say*
A. puncticollis *Say*
Anaspis nigra *Hald.*
A. flavipennis *Hald.*
A. rufa *Say*
Tomoxia bidentata *Say*
Mordella borealis *Lec.*
M. melaena *Germ.*
M. marginata *Melsh.*
Mordellistena biplagiata *Helm.*
M. atriceps *Smith*
M. comata *Lec.*
M. aspersa *Melsh.*
M. pustulata *Melsh.*
M. convicta *Lec.*
Corphyra newmani *Lec.*
C. lugubris *Say*
C. collaris *Say*
Notoxus anchora *Say*
Anthicus rejectus *Lec.*
Pyrochroa flabellata *Fabr.*
Schizotus cervicalis *Newm.*
Dendroides canadensis *Lat*
D. concolor *Newm.*
Meloe angusticollis *Say*
Pomphopoea sayi *Lec.*
Hormorus undulatus *Uhl.*
Cyphomimus dorsalis *Horn*
Sitones hispidulus *Germ.*
S. flavescens *Marsh*
S. tibialis *Herbst*
Ithycerus noveboracensis *Forst.*
Apion rostrum *Say*
Phytonomus punctatus *Fabr.*
P. nigrirostris *Fabr.*
Hylobius confusus *Kirby*
Bagous obliquus *Lec.*
Magdalis barbita *Say*
M. pandura *Say*
M. armicollis *Say*
Anthonomus signatus *Say*
A. rufipennis *Lec.*
A. corvulus *Lec.*
A. crataegi *Walsh*
A. canus *Lec.*
Orchestes pallicornis *Say*
O. niger *Horn*

Orchestes ephippiatus *Say*
Piazorhinus scutellaris *Say*
Gymnetron teter *Fabr.*
Conotrachelus juglandis *Lec.*
C. nenuphar *Herbst*
C. anaglypticus *Say*
Tyloderma aereum *Say*
Cryptorhynchus parochus *Herbst*
Piazurus oculatus *Say*
Coeliodes curtus *Say*
Acoptus suturalis *Lec.*
Ceutorhynchus affluentus *Dietz*
C. sulcipennis *Lec.*
C. semirufus *Lec.*
C. septentrionalis *Gyll.*
Pelenomus sulcicollis *Fabr.*
Rhinoncus pyrrhopus *Lec.*
Baris strenua *Lec.*
Aulobaris naso *Lec.*
Sphenophorus sculptilis *Uhl.*
Calandra granaria *Linn.*
Cossonus platalea *Say*
Stenocelis brevis *Boh.*
Monorthrum mali *Fitch*
Pityophthorus minutissimus *Zimm*
Xyloterus bivittatus *Kirby*
X. politus *Say*
Xyleborus obesus *Lec.*
Hylesinus aculeatus *Say*
H. opaculus *Lec.*
Eurymycter fasciatus *Oliv.*
Cratoparis lunatus *Fabr.*

LIST OF PUBLICATIONS OF THE ENTOMOLOGIST

The following is a list of the principal publications of the entomologist during the year 1902. 64 are given with the title,[1] place and time of publication and a summary of the contents of each. Volume and page number are separated by a colon, the first superior figure tells the column, and the second the exact place in the column in ninths; e. g. 66: 842[27] means vol. 66, p. 842, column 2, beginning in the seventh ninth, i. e. about seven ninths of the way down.

Hackberry Gall (Country Gentleman, Oct. 17, 1901, 66:842[27])

The gall of Pachypsylla celtidis-mamma Riley, from Greenwich R. I., is briefly described and the insect characterized.

Dying White Pines (Troy Budget, Oct. 27, 1901, p.12; Argus [Albany] Nov. 17, p.13)

An account of injuries to white pines in the Hudson river valley by Tomicus calligraphus Germ., and associated species.

Seventeen Year Cicada (Country Gentleman, Nov. 7, 1901, 66:902[23])

Gives distribution of brood of Cicada septendecim Linn. to appear in 1902 and indorses advice to refrain from setting young trees or close pruning in sections where the insect is abundant.

Cigar Case-bearer (Country Gentleman, Nov. 7, 1901, 66:902[28])

The cases are described and the habits of Coleophora fletcherella Fern. given.

[1]Titles are given as published; and in some instances they have been changed or supplied by the editors of the various papers.

Katydid Eggs (Country Gentleman, Nov. 14, 1901, 66:922[2])

Identifies and describes the oviposition of Microcentrum retinervis Burm.

Scale Insects of Importance and List of the Species in New York State (N. Y. State Mus. Bul. 46. June 1901 [issued Nov. 15]. 94p., 15 plates [seven colored])

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San José Scale (Worcester [Mass.] Sunday Telegram, Nov. 17, 1901, p.7)

Summary account of Aspidiotus perniciosus Comst.

[1]A general account and bibliography of each is given.

Aquatic Insects of the Adirondacks. A study conducted at the entomologic field station, Saranac Inn N. Y., under the direction of the state entomologist, by James G. Needham Ph.D. and Cornelius Betten M.A. (N. Y. State Mus. Bul. 47. Sep. 1901 [issued Nov. 18]. 234p. 36 plates [six colored])

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Entomology and Entomologists in New York State (Argus [Albany] Dec. 3, 1901, p.5)

Abstract of annual address delivered before the Entomological Society of Albany.

Slaking Lime (Country Gentleman, Jan. 2, 1902, 67:6[35])

Slaking and kind of lime to be used for bordeaux mixture.

Elm Leaf Beetle (Troy Budget, Jan. 12, 1902, p.6; Argus [Albany] Feb. 2, p.12)

Injuries, distribution and means of controlling Galerucella luteola Müll. The work of the Laurel Hill Association of Stockbridge Mass. mentioned.

Insects Injurious to Elm Trees (Commissioners of Fisheries, Game and Forest. 5th Rep't, 1900 [rec'd Jan. 16, 1902] p.351–79; separate, issued Mar. 17, 1902)

Directions are given for the use of insecticides and the following species are noticed briefly: Elm leaf beetle, Galerucella luteola Müll.; bag or basket worm, Thyridopteryx [ephemeraeformis Haw.; fall webworm, Hyphantria cunea Drury; spiny elm caterpillar, Euvanessa antiopa Linn., elm borer, Saperda tridentata Oliv. and elm bark louse, Gossyparia ulmi Geoff.

Two New Species of Ophion (Psyche, Feb. 1902, 9:307–8)

Technical descriptions of Ophion arcuatum and O. appendiculatum, n. sp.

Further Notes on Crude Petroleum and Other Insecticides (U. S. Dep't Agric. div. ent. Bul.31. n. s. 1902. p.49–51)

Results obtained with crude petroleum, whale oil soap, etc.

The Hessian Fly in New York State in 1901 (U. S. Dep't Agric. div. ent. Bul. 31. n. s. 1902. p.22–24)

Prevalence, damage and observations on broods of Cecidomyia destructor Say.

Observations on Forest and Shade Tree Insects in New York State (U. S. Dep't Agric. div. ent. Bul. 31. n. s. 1902. p. 63–68)

Notes on the following: Anisota senatoria Abb. & Sm., Cacoecia argyrospila Walk., Chalcophora virginiensis Drury, C. liberta Germ., Anomala lucicola Fabr., Monohammus scutellatus Say, M. titillator Fabr., M. confusor Kirby, Glyptocelis hirtus Oliv. [pubescens Fabr.], Pissodes strobi Peck, Magdalis lecontei Horn, M. alutacea Lec., Dendroctonus terebrans Oliv., Tomicus calligraphus Germ., T. cacographus Lec., T. pini Say, T. balsameus Lec., Xylotrechus sagittatus Germ., Galerucella luteola Müll., Clisiocampa disstria Hübn., Prionoxystus robiniae Peck, Lecanium nigrofasciatum Perg., Pseudococcus aceris Geoff. [Phenacoccus acericola King], and Chermes pinicorticis Fitch.

Ladybugs and Carpet Beetles (Country Gentleman, Feb. 13, 1902, 67:133[a])

Two spotted ladybug, Adalia bipunctata Linn., is characterized, and the Buffalo carpet beetle, Anthrenus scrophulariae Linn., and the black carpet beetle, Attagenus piceus Oliv., are briefly described and remedial measures given.

Soft Scale on Fern (Country Gentleman, Feb. 13, 1902, 67:133[a])

Lecanium hesperidum Linn. is briefly described, and the use of Ivory soap, a 5 cent cake to 8 gallons of water, advised.

Report of the Committee on Insects of the Eastern New York Horticultural Society (Eastern N. Y. Hortic. Soc. Proc. 5th annual meeting, 1901 [issued Feb. 1902] p.20–26)

Gipsy moth, Porthetria dispar Linn., fruit tree bark beetle, Scolytus rugulosus Ratz., palmer worm, Ypsolophus pometellus Harris, and the forest tent caterpillar, Clisiocampa disstria Hübn., were noticed in particular. The results obtained with kerosene, whale oil soaps and crude petroleum in various combinations are given briefly.

School Children and San José Scale (Worcester [Mass.] Evening Gazette, Feb. 17, 1902, p.3)

Letter advising the enlistment of school children as aids in detecting the San José scale, Aspidiotus perniciosus Comst., about Worcester Mass.

Hickory Bark Borer (Livingston Democrat [Geneseo N. Y.] Feb. 26, 1902, p.3)

Injuries of Scolytus 4-spinosus Say in the Genesee valley, earlier outbreaks, natural history and remedies.

Forest Tent Caterpillar (Country Gentleman, Mar. 6, 1902, 67:196[6]–97[2])

Remedial measures against Clisiocampa disstria Hübn.

Spraying for Cicada (Country Gentleman, Mar. 13, 1902, 67:219[15])

Spraying recently emerged cicadas, Cicada septendecim Linn., with a contact insecticide is advisable only in limited areas.

San José Scale Investigations (Country Gentleman, Mar. 13, 1902, 67:221[21])

Criticism of results on Aspidiotus perniciosus Comst., obtained by Professors Lowe and Parrott. *See* N.Y. Agric. Exp. Sta. Bul. 202.

Fumigation (Country Gentleman, Mar. 27, 1902, 67:262[25])

Value of hydrocyanic acid gas against bedbugs, Acanthia lectularia Linn., and hen lice.

Report on Insects for 1901, read before Eastern New York Horticultural Society Feb. 12, 1902 (Country Gentleman, Mar. 27, 1902, 67:265[21], 290[1]–91[9], 308[21])

The following insects were noticed: giant swallowtail, Heraclides cresphontes Cram., cicada-killer, Sphecius speciosus Drury, Hessian fly, Cecidomyia destructor Say, squash bug, Anasa tristis DeGeer. The value of trap lanterns was commented on, and the results obtained by the use of various insecticides against the San José scale were given. The fruit tree bark beetle, Scolytus rugulosus Ratz., the hickory bark borer, Scolytus 4-spinosus Say, the roundheaded appletree borer, Saperda candida Fabr., the elm leaf beetle, Galerucella luteola Müll., the grapevine Fidia, Fidia viticida Walsh, the peach twig moth, Anarsia lineatella Zell., Cenopis diluticostana Wlsm., and the carrot rust fly, Psila rosae Linn., were also noticed.

Bark Louse (Country Gentlemen, Ap. 10, 1902, 67:306[14])

Remedies for Mytilaspis pomorum Bouché.

White Scale (Country Gentleman, Ap. 17, 1902, 67:329[15])

Remedies for Aspidiotus hederae Vall.

Insect Enemies to Shade Trees (Col. State Board Hortic. Rep't, 1901. 1902 [rec'd Ap. 22] 13:164–70)

Some general considerations in preventing insect depredations with brief notices of the following species: Gipsy moth, Porthetria dispar Linn., leopard moth, Zeuzera pyrina Linn., white marked tussock moth, Notolophus leucostigma Abb. & Sm., spiny elm caterpillar, Euvanessa antiopa Linn., locust borer, Prionoxystus robiniae Peck, poplar borer, Saperda calcarata Say, cottonwood leaf beetle, Lina scripta Fabr. and cottony mapletree scale insect, Pulvinaria innumerabilis Rathv.

Tussock Moth (Country Gentleman, Ap. 24, 1902, 67:351[24])

Remedial measures are given for the white marked tussock moth, Notolophus leucostigma Abb. & Sm.

Scale Insects (Country Gentleman, May 1, 1902, 67:370[14])

Remedial measures for Chionaspis furfura Fitch and Aspidiotus perniciosus Comst. from Dorchester Mass.

May Beetles (Country Gentleman, May 8, 1902, 67:390[15])

There is no practical method of protecting trees from Lachnosterna ? fusca Fröhl.

Bagworms (Country Gentleman, May 8, 1902, 67:390[16])

The winter retreats, containing from 532 to 1284 eggs, are described and remedies are given for Thyridopteryx ephemeraeformis Haw.

Grape Root Worm (Country Gentleman, May 15, 1902, 67:413[11])

General account of Fidia viticida Walsh in New York and a discussion of remedies.

Tent Caterpillars (Country Gentleman, May 15, 1902, 67:414[13])

Brief note of warning in regard to Clisiocampa americana Fabr. and C. disstria Hübn.

Insect Pests and Plant Diseases (N. Y. State Lib. Bul. 72. 1902. p.181–83)

General summary of earlier laws and review of those enacted in the United States in 1901.

Insects in New York (Country Gentleman, May 22, 1902, 67:434[45])

Summary of reports from voluntary observers.

Appletree Tent Caterpillar (Country Gentleman, May 22, 1902, 67:438[46]–39)

Remedies are given for Clisiocampa americana Fabr. and the habits of the fall webworm, Hyphantria cunea Drury [textor Harris], are briefly described.

Onion Thrips (Country Gentleman, May 29, 1902, 67:451[13])

Injuries and remedies for Thrips tabaci Lind.

Insects in New York (Country Gentleman, May 29, 1902, 67:454[28])

Summary of reports from voluntary observers.

Elm Tree Bark Louse (Country Gentleman, June 5, 1902, 67:471[11])

The habits and remedies for Gossyparia ulmi Geoff. are given.

Insects in New York (Country Gentleman, June 5, 1902, 67:471[29])

Summary of reports from voluntary observers.

Hopvine Aphis (Country Gentleman, June 12, 1902, 67:490[25])

Life history and remedial measures for Phorodon humuli Schrank.

Owl Beetle (Country Gentleman, June 12, 1902, 67:490[35])

Description and habits of Alaus oculatus Linn.

Gartered Plume Moth (Country Gentleman, June 12, 1902, 67:491[12])

Life history and remedies for Oxyptilus periscelidactylus Fitch

Insects in New York (Country Gentleman, June 12, 1902. 67:499[24])

Summary of reports from voluntary observers.

Insects of New York (Country Gentleman, June 19, 1902, 67:519[27])

Summary of reports from voluntary observers.

Lined Spittle Hopper (Country Gentleman, June 26, 1902, 67:530[17])

The work of Ptyelus [Philaenus] lineatus Linn. on grass described, and Aphrophora paralella Say on hard pine mentioned.

Silver Tip (Country Gentleman, June 26, 1902, 67:531[24])

This may be the work of several insects: Limothrips poaphagus Comst., larvae of Chlorops and Meromyza or Jassidae.

Insects in New York (Country Gentleman, June 26, 1902, 67:539[25])

Summary of reports from voluntary observers.

Grapevine Root Worm (Country Gentleman, July 10, 1902, 67:574–75)

Cultivation will destroy a large proportion of the pupae of Fidia viticida Walsh.

Insects in New York (Country Gentleman, July 10, 1902, 67:579[20])

Summary of reports from voluntary observers.

[Directions for Collecting Mosquitos] (Argus [Albany] July 27, 1902, p.14; Waterloo Observer, July 25, 1902, p.1)

Request for specimens from all parts of the State with directions for collecting.

Spread of Elm Leaf Beetle (New York Farmer, Aug. 21, 1902, p.4)

Observations on spread of Galerucella luteola Müll. about Albany and its carriage by electric cars.

Aquatic Insects of the Saranac Region (Forest, Fish and Game Commission. 6th Rep't, 1901 [issued Aug. 1902] p.499–531, six colored plates)

The introduction briefly describes the investigations of the office and discusses the complexity and interrelations existing among aquatic forms, with a chapter on the value of insects as food for fish. The economic importance of the following orders as fish food is briefly treated: stone flies (Plecoptera), May flies (Ephemeridae), drazon flies (Odonata), fish flies, dobson and others (Neuroptera), caddis flies (Trichoptera) and flies (Diptera). Brief notes from Dr Needham's report (Museum bulletin 47) are given on the species known to occur in the region, and most of the illustrations are taken from the same publication.

Injuries by Elm Leaf Beetle (Albany Evening Journal, Aug. 26, 1902, p.10)

Brief note calling attention to injuries by Galerucella luteola Müll.

San José Scale (Country Gentleman, Aug. 28, 1902, 67:711[17])

Remedies for Aspidiotus perniciosus Comst.

Elm Leaf Beetle [Galerucella luteola Müll.] in New York State (N. Y. State Mus. Bul. 57, Entomology 15, p.1–43, 8pl. [revised edition of Museum bulletin 20, issued Aug. 27])

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Hag Moth Caterpillar (Country Gentleman, Sep. 4, 1902, 67:730[25])

The food habits and life history of Phobetron pithecium Abb. & Sm. are given.

17th Report of the State Entomologist on Injurious and Other Insects of the State of New York (N. Y. State Mus. Bul. 53. 1901. [Issued Sep. 12, 1902] p.699–925, 29fig. 6pl.)

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Scale Insects of Importance (American Gardening, Sep. 13, 1902, 22:593–94)

Reprint of portions of Museum bulletin 46 on above group.

Asparagus Beetle (Country Gentleman, Oct. 2, 1902, 67:810)

Remedies for Crioceris asparagi Linn.

Report on Insects (N. Y. State Fruit-Growers Ass'n Rep't. 1902. 6th An. Rep't 1902. p.210–18)

Brief notes on the unusual occurrence of a number of southern species.

Report of the Committee on Insects (Eastern N. Y. Hortic. Soc. 6th An. Rep't 1902. p.210–18)

Some general observations on the abundance of southern forms are given together with notes on the value of trap lanterns, and the results of recent experiments with various insecticides against San José scale. The injuries inflicted by various bark borers are briefly recorded, and the following insects are noticed: Hickory bark borer, Scolytus 4-spinosus Say; elm leaf beetle, Galerucella luteola Müll; grapevine Fidia, Fidia viticida Walsh; forest tent caterpillar, Clisiocampa disstria Hübn.; Cenopis diluticostana Walsm.; carrot rust fly, Psila rosae Fabr.; rose scale insect, Aulacaspis rosae Sandb.; European praying mantis, Mantis religiosa Linn.

CONTRIBUTIONS TO COLLECTION OCT. 16, 1901–OCT. 15, 1902

Hymenoptera

Eumenes fraternus Say, fraternal potter wasp, cells on small branch, May 10; from **G. S. Graves**, Newport N. Y.

Agapostemon radiatus Say, Oct. 8; from Mrs **E. C. Anthony**, Gouverneur N. Y.

Thalessa atrata Fabr., the black long-sting, June 17; from **C. Horton**, Albany N. Y.

Microgaster sp., cocoons, Nov. 11; from **L. L. Woodford**, Lyndonville N. Y.

Cratotechus sp., pupal cases on soft maple, July 27; from **W. T. Ropes**, Montclair N. J.

Tremex columba Linn., pigeon tremex, Aug. 30; from **W. S. Evans**, Newport N. Y.

Monostegia ignota Nort., strawberry sawfly, larvae on strawberry plants, June 2; from **C. L. Williams**, Glens Falls N. Y.

Eriocampoides limacina Retz., peartree slug, larva on cherry, Sep. 12; from **Calvin Shaffer**, Albany N. Y.

Coleoptera

Scolytus quadrispinosus Say, adults and larvae on hickory logs, January; from **W. W. Wadsworth**, Geneseo N. Y.

Cryptorhynchus lapathi Linn., willow snout beetle, on poplar and willow, July 18; from **C. W. Stuart & Co.**, Newark N. Y. Same on willow, Aug. 28; from **J. Jay Barden**, Newark N. Y.

Pissodes strobi Peck, the white pine weevil, pupae and adults, Aug. 28; from **Ernest H. Crosby**, Rhinebeck N. Y.

Lixus concavus Say, rhubarb curculio, June 26; from **H. H. Ballard**, Pittsfield Mass.

Epicauta cinerea Forst., margined blister beetle on potatoes, July 14; from **G. F. Bixby**, Plattsburg N. Y.

Chelymorpha argus Licht., argus beetle, adults on corn, July 18; from **S. B. Huested**, Blauvelt N. Y.

Galerucella luteola Müll., elm leaf beetle, adults on elm, Ap. 25; from **S. S. Vrooman**, Schenectady N. Y.

Fidia viticida Walsh, grapevine root worm, larvae on grapevine, Ap. 24; from Westfield N. Y. Same, May 18; from **F. A. Morehouse**, Ripley N. Y.

Oberea bimaculata Oliv., raspberry cane-girdler, adult on raspberry, July 11; from Dr **C. C. Schuyler**, Plattsburg N. Y.

Saperda fayi Bland, larvae in crataegus, Ap. 17; from **M. F. Adams**, Buffalo N. Y.

Monohammus confusor Kirby, the sawyer, adults, July 3; from **Carlton Turner**, Worcester N. Y. Same on pine, Aug. 4; from **B. Middlebrook**, Albany N. Y.

Prionus laticollis Drury, broad-necked Prionus, larva and pupa, June 24; from **G. S. Graves**, Newport N. Y.

Orthosoma brunneum Forst., straight-bodied Prionus, July 30; from **James E. Barkley**, Grahamsville N. Y.

Pelidnota punctata Linn., spotted grapevine beetle, adult, Aug. 4; from **L. Emmet**, Albany N. Y.

Dicerca divaricata Say, divaricated Buprestid, July 30; from **James E. Barkley**, Grahamsville N. Y.

Wireworm, undetermined, infested with Cordyceps acicularis, Dec. 25; from **C. W. Nash**, Toronto Can.

Alaus oculatus, Linn., owl beetle, adult, June 3; from **C. P. S.**, Schenectady N. Y. Same June 18; from **B. D. Van Buren**, Olcott N. Y. Same July 30; from **James E. Barkley**, Grahamsville N. Y.

Attagenus piceus Oliv., black carpet beetle, larvae in flour warehouse, May 21; from **Julian Van Deusen**, Hudson N. Y.

Silvanus surinamensis Linn., saw-toothed grain beetle, adult on oats, Oct. 18; from Mr **Freer**, Albany N. Y.

Chilocorus bivulnerus Muls., twice-stabbed ladybug, adults on San José scale-infested tree, May 2; from **J. J. Hicks**, Jericho L. I. Same, pupa on apple, Aug. 23; from **W. L. Downing**, Oneida N. Y.

Diptera

Psila rosae Fabr., the carrot rust fly, larvae in celery roots, Dec. 30; from **James Granger**, Broadalbin N. Y.

Lasioptera vitis O.S., grapevine gall insect, larvae in galls on grape leaves and stem, June 16; from **J. Jay Barden**, Westfield N. Y.

Culex excrucians Walk. and Anopheles punctipennis Say, mosquitos, adults, July 25; from Percy L. Huested, Pine Island N. Y.

Rhabdophaga salicis Schrank, European willow gall midge, larvae on European willow, Ap. 15; from H. C. Peck, Rochester N. Y.

Lepidoptera

Euvanessa antiopa Linn., spiny elm caterpillar, larvae on willow, alder, June 22; from G. S. Graves, Newport N. Y. Same, on willow (Salix discolor), June 30; from C. R. Pettis, Saranac Junction N. Y.

Eurymus philodice Godt., clouded sulfur, adult, Oct. 22; from J. P. Van Ness, East Greenbush N. Y.

Heraclides cresphontes Cram., giant swallowtail, July 15; from Henry Griffis, Newpaltz N. Y.

Hemaris diffinis Bdv., July 30; from James E. Barkley, Grahamsville N. Y.

Amphion nessus Cram., June 16; from J. F. Rose, South Byron N. Y.

Thyreus abbotii Swains., Abbot's sphinx, larvae on Ampelopsis, July 25; from W. B. Phipp, Delmar N. Y.

Philampelus pandorus Hübn., pandorus sphinx, larva on grape, May 30; from H. L. Griffis, Newpaltz N. Y.

Phlegethontius celeus Hübn., tomato worm, on tomato, Aug. 21; from C. H. Peck, Menands N. Y. Same, adult, Aug. 30; from Dr U. G. Williams, Newport N. Y.

Sphinx drupiferarum Abb. & Sm., plum sphinx, June 16; from J. Jay Barden, Westfield N. Y. Same, male and female, June 17; from J. H. Dodge, Rochester N. Y.

? Paonias excaecatus Abb. & Sm., blind eyed sphinx, young larvae on oak, June 20; from Rhoda Thompson, Ballston Spa N. Y.

Arctia virgo Linn., July 30; from James E. Barkley, Grahamsville N. Y.

Pyrrharctia isabella Abb. & Sm., the black and red woolly bear, larvae, Oct. 22; from J. P. Van Ness, East Greenbush N. Y.

Notolophus antiqua Linn., larva on Crataegus, July 22; from G. S. Graves, Newport N. Y.

Phobetron pithecium Abb. & Sm., hag moth caterpillar, larva on maple, Aug. 26; through *Country Gentleman*, Westwood N. Y.

Thyridopteryx ephemeraeformis Haw., bagworm, bags on cedar, Jan. 24; from Dr M. W. Van Denburg, Mount Vernon N. Y. Eggs of same on yellow locust, Ap. 21; from J. J. Hicks, Jericho L. I. Eggs of same on plum, Ap. 28; from Weaverling & Biddle, Everett Pa. Same on arbor vitae, May 6; from Mrs E. H. Mairs, Dobbs Ferry N. Y.

Schizura concinna Abb. & Sm., red-humped appletree worm, larva on apple, Oct. 4; from Cyrus R. Crosby, Penn Yan N. Y.

Tropaea luna Linn., luna moth, adult, June 3; from J. H. McClure, Franklinville N. Y. Same; from James E. Barkley, Grahamsville N. Y.

Telea polyphemus Linn., polyphemus moth, Aug. 9; from B. Middlebrook, Albany N. Y.

Clisiocampa americana Fabr., appletree tent caterpillar, larva on appletree, May 11; from Lloyd Balderston, Colora Md.

Xylophasia arctica Bdv., July 30; from James E. Barkley, Grahamsville N. Y.

Hydroecia species, larva on ginseng, July 30; from H. W. Elmendorf, Coeymans Hollow N. Y.

Euthisanotia grata Fabr., beautiful wood nymph, adult on hollyhock, June 30; from F. A. Fitch, Randolph N. Y. Same on Boston ivy, June 30; from Mrs E. C. Anthony, Gouverneur N. Y. Same, July 30; from James E. Barkley, Grahamsville N. Y. Same, Aug. 2; from G. S. Graves, Newport N. Y.

Heliothis armiger Hübn., the corn worm, larvae on corn, Aug. 25; from Dr M. W. Van Denburg, Mount Vernon N. Y.

Geometrid sp., larva on Crataegus, July 22; from G. S. Graves, Newport N. Y.

Pyralis costalis Fabr., clover hay caterpillar, larvae in timothy hay, Ap. 9; from George B. Kinney, Amenia N. Y.

? Tetralopha species, larvae on maple, Sep. 2; from E. H. Crosby, Rhinebeck N. Y.

Dioryctria abietella Shiff., larvae in spruce cones, Sep. 24; from C. R. Pettis, Fulton Chain N. Y.

Ephestia kuehniella Zell., Mediterranean flour moth, pupae in graham flour, Oct. 4; from Dr **M. W. Van Denburg,** Mount Vernon N. Y.

Oxyptilus periscelidactylus Fitch, gartered plume moth, larvae on grapevine, June 2; from **David Muirhead,** Staten Island N. Y. Same, June 10; from **Verplanck Colvin,** Albany N. Y.

Phoxopteris nubeculana Clem., apple leaf-folder, larvae on apple, Sep. 4; from **Charles V. Winne,** Albany.

Coleophora fletcherella Fern., cigar case-bearer, larvae, Nov. 1; from **F. D. A.,** Wings Station N. Y.

Coleophora limosipennella Dup., larvae on Scotch elm, July 18; from **Walter W. Hoover,** Brooklyn N. Y.

Bucculatrix canadensisella Chamb., birch Bucculatrix, larvae on birch, Sep. 16; from **C. H. Peck,** Lake Placid N. Y.

Aspidisca splendoriferella Clem., resplendent shield-bearer, cocoon on apple, January; through State Dep't Agric., Chautauqua county, N. Y.

Neuroptera

Chrysopa sp., lace-winged fly, adult, June 10; from **Verplanck Colvin,** Albany N. Y.

Corydalis cornuta Linn., horned corydalis, male, July 10; from **J. N. Wright,** Grand Gorge N. Y. Same, July 21; from **F. W. Vail,** Milton N. Y. Same, July 30; from **J. R. Boynton,** Altamont N. Y. Same, Aug. 1; from **C. A. Wieting,** Cobleskill N. Y. Same, Sep. 12; from **C. E. Chapman,** Peruville N. Y.

Hemiptera

Blissus leucopterus Say, chinch bug, adults on rye, June 18; from **Purley Minturn,** Locke N. Y.

Phymata wolffii Stal., ambush bug, adult on pear Sep. 1; from **J. F. Rose,** South Byron N. Y.

Stenopoda culiciformis Fabr., adult, August; from **H. H. Ballard,** Pittsfield Mass., from the South.

Typhlocyba comes var. vitifex Fitch, grapevine leaf-hopper, work on grape leaves, June 3; from **J. Jay Barden,** Westfield N. Y.

Philaenus lineatus Linn., lined spittle hopper, young on grass, June 18; from **L. L. Woodford,** Scriba N. Y.

Ceresa bubalus Fabr., Buffalo tree hopper, eggs in pear twig, Oct. 25; from **L. L. Woodford,** Waterport N. Y.

Chionaspis americana Johns., elm scale insect, adult females on elm, Jan. 16; from **J. Jay Barden,** Newark N. Y.

Chionaspis furfura Fitch, scurfy bark louse, eggs on apple, Jan. 6; from **C. H. Stewart,** Newark N. Y. Same, eggs on pear, Ap. 19; **O. F. R.,** Dorchester Mass. Same, on apple, Aug. 23; from **W. L. Downing,** Oneida N. Y. Same, on pear, Aug. 28; from **J. H. Dodge,** Olcott N. Y.

Mytilaspis pomorum Bouché, appletree bark louse, adults on apple, Mar. 29; from **E. R. Hequan,** Washington county, N. Y. Eggs of same on willow, May 23; from **S. T. Skidmore,** East Hampton N. Y.

Aulacaspis rosae Sandb., rose scale, adults and young on crimson rambler rose, Oct. 15; from **C. W. Calkins,** Cobleskill N. Y. Same, females on raspberry, Oct. 17; from **J. F. Mara,** Cornwall N. Y. Same, females on blackberry, Oct. 30; from **Chester Young,** New York city. Same, females on rose, Jan. 16; from **J. Jay Barden,** Stanley N. Y.

Chrysomphalus aonidum Linn., young females on rubber plant, Nov. 30; from **L. L. Woodford.** Lyndonville N. Y.

Diaspis pentagona Targ., West Indian peach scale, adult females on cherry, Jan. 23; from **Chester Young,** New York customhouse N. Y.

Aspidiotus ancylus Putn., Putnam's scale, adult, Oct. 18; from **H. C. Peck,** Rochester N. Y. Same, young females on Osage orange, Oct. 29; from **P. L. Heusted,** Coxsackie N. Y. Same, adult female on currant, Dec. 13; from **C. H. Darrow,** Geneva N. Y. ? Same, on ? Acer pennsylvanicum, Ap. 15; from **J. F. Rose,** South Byron N. Y. Same, females on Kieffer pear, May 12; from **B. D. Van Buren,** Albion N. Y. Same, young, second stage, on willow, May 12; from **Chester Young,** New York city.

Aspidiotus forbesi Johns., cherry scale insect, female on apple, Oct. 30; from **Chester Young,** Westchester Pa. ? Same, young, second stage, on peach, Ap. 2; from **P. L. Heusted,** Highland N. Y.

Aspidiotus hederae Vallot, white scale insect of the ivy, adults on ivy, Mar. 29; from **J. Richards, Sherborn Mass.**

Aspidiotus ostreaeformis Curtis, European fruit tree scale insect, young females on plum, Oct. 25; from C. W. Cole, Irondequoit N. Y. Same, or ancylus Putn., second stage young on pear, Oct. 25; from C. W. Cole, Irondequoit N. Y. Same, young female on plum, Nov. 15; from L. L. Woodford, Lyndonville N. Y. Same, adult females, young, on lilac, Mar. 15; State Dep't Agric., Belgium, Europe. Same, adult female on plum, June 13; from B. D. Van Buren, Olcott N. Y.

Aspidiotus perniciosus Comst., San José scale, female on apple, Oct. 28; from B. D. Van Buren, Waterport N. Y. Same, adults and young, on willow, Mar. 27; from C. L. Allen, Floral Park L. I. Same, young females on apple, May 5; from J. F. Johnson, Breakabeen N. Y. Young of same on peach, May 22; from Louis F. Brown, Washingtonville N. Y. All stages of same on apple, Aug. 13; from Emily Thomas, Union Springs N. Y.

Lecanium nigrofasciatum Perg., adults on willow, Mar. 24; from J. J. Barden, Stanley N. Y.

Lecanium pruinosum Coq., frosted lecanium, eggs on American elm, May 30; from J. M. Southwick, Providence R. I.

Lecanium ? quercitronis Fitch, adults on ironwood, June 11; from C. E. Eldridge, Leon N. Y.

Lecanium tulipiferae Cook, tuliptree scale, young on tuliptree, Jan. 20; from Mrs E. H. Mairs, Irvington N. Y.

Pulvinaria innumerabilis Rathv., cottony mapletree scale insect, adults on maples, June 11; from C. E. Eldredge, Leon N. Y. Same, on elm, July 27; from W. T. Ropes, Montclair N. J.

Eriopeltis sp., adults on grass, collected in August 1899; from C. O. Houghton, Stark N. Y.

Gossyparia ulmi Geoff., elm bark louse, adults on American elm, May 19; from O. Q. Flint, Athens N. Y. Same, females on elm, May 23; from J. M. Southwick, Providence R. I. Same, females on weeping elm, May 24; from T. C. M., New Dorp N. Y.

Pemphigus populicaulis Fitch, adults on poplar, June, 23; from W. B. Melius, Albany N. Y.

Phylloxera caryaecaulis Fitch, hickory gall aphid, galls on leaf stalks of hickory, June 16; from L. L. Woodford, Madison county. Same, few females and many young on hickory, June 17; from Dr F. W. Seward, Goshen N. Y.

Phylloxera vitifoliae Fitch, galls on Delaware grapevines, Sep. 4; from **P. L. Heusted**, Marlboro N. Y.

Schizoneura americana Riley, elm leaf aphis, adults on American elm, May 30; from **J. M. Southwick**, Providence R. I.

Orthoptera

Oecanthus angustipennis Fitch, adult, Sep. 22; from **H. L. Griffis**, Newpaltz N. Y.

?Microcentrum retinervis Burm., katydids, eggs on magnolia twig, Ap. 15; through State Dep't Agric., Rockland county. Same, eggs on apple, Nov. 4; from **W. L. M.**, Augusta county, Va.

Diapheromera femorata Say, walking stick, Oct. 9; from **L. L. Woodford**, Berwyn N. Y.

Tenodera sinensis Sauss., Chinese praying mantis, eggs on imported Japanese maples, Ap. 12; from **P. L. Huested**, Blauvelt N. Y.

Acarina

Trombidium locustarum Riley, locust mite, half grown young on grasshopper, Sep. 17; from **Henry L. Griffis**, Newpaltz N. Y.

Myriapoda

Julus ?caeruleocinctus Wood., young on strawberries, June 24; from **C. H. Peck**, Menands N. Y.

Vermes

Gordius sp., hair worm on hair snake, coiled in knots in soil, May 12; from **C. E. Eldredge**, Leon N. Y.

EXPLANATION OF PLATES

PLATE 1[1]

Brown tail moth

Euproctis chrysorrhoea Linn.

1 Egg mass on the underside of a pear leaf and also on twig
2 Young caterpillars or larvae as they appear in early spring
3 Half grown and full grown caterpillars
4 Pupae in portion of a web mass, also a few cast larval skins
5 Male moth at rest
6 Female moth with wings partly extended
7 Hibernating tents in which the winter is passed

PLATE 2

Tree 114 was sprayed with undiluted petroleum Ap. 11, 1900, and with a 20% mechanical petroleum emulsion in the spring of 1901 and of 1902. The first application undoubtedly injured the tree considerably, but under the later treatments it has been recovering, as is evidenced by the new twigs shown in the view taken Mar. 10 and the abundant bloom of May 6.

Tree 66 was treated with a combination of whale oil soap and crude petroleum in April 1900 and with 25% and 20% mechanical crude petroleum emulsion in the springs of 1901 and 1902 respectively. It was severely cut back in 1901, and the recent growth gives no indication of weakness.

PLATE 3

Tree 101 was sprayed with undiluted crude petroleum in April 1900 and severely injured. The following spring it was treated with a combination of whale oil soap and petroleum and in the spring of 1902 with a 20% mechanical emulsion. It has developed a large amount of vigorous new wood.

Tree 69 was treated with a combination of whale oil soap and crude petroleum in April 1900, and with 25% and 20% mechanical crude petroleum emulsion respectively in the spring of 1901 and 1902. The vigorous growth under this treatment is very apparent.

[1]Executed from nature under the author's direction by L. H. Joutel.

PLATE 4

Tree 4 was sprayed with the lime, salt and sulfur mixture in the spring of 1902 with no indication of injury to the bloom.

Tree 113 was treated in April 1900 with a mixture of whale oil soap and crude petroleum and the two following springs with a 20% mechanical crude petroleum emulsion. There is no sign of injury, and the profuse bloom shows that the buds were not harmed.

PLATE 5

Trees 41 and 47 have been sprayed three springs in succession with a 20% mechanical crude petroleum emulsion, except that in the case of the former a 25 % emulsion was applied in 1901. Little or no injury has resulted, and the somewhat abundant bloom shows that the buds were not affected to any extent.

PLATE 6

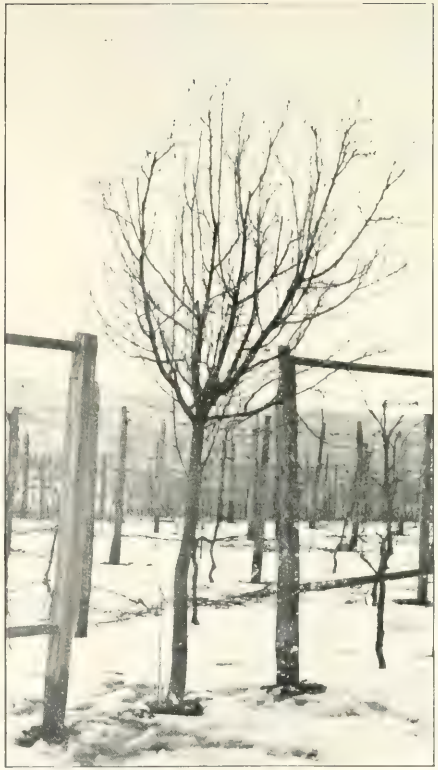
1 Work of willow and poplar curculio, Cryptorhynchus lapathi Linn.

2 Nun moth, Psilura monacha Linn; slightly enlarged.

3 Birch leaf Bucculatrix, Bucculatrix canadensisella Chamb., *a*, skeletonized leaf; *b*, molting cocoon; *c*, larva; *d*, head of larva; *e*, anal segments of larva; *f*, same of pupa; *g*, cocoon with extruded pupal skin; *h*, moth — all enlarged. (From *Insect Life*)

L. H. Joutel, 1902

Brown-tail moth



Tree 114 Photo March 10
Seckel pear

Tree 114 Photo May 6
Seckel pear

Tree 66 Photo March 10
Bartlett pear

THREE YEARS OF CRUDE PETROLEUM

Tree 101 Photo March 10

Seckel pear

Tree 69 Photo March 10

Howell pear

Tree 4 Photo May 6

Wild cherry

LIME, SALT AND SULFUR, 1902

Tree 113 Photo May 6

Beurre d'Anjou pear

THREE YEARS OF CRUDE PETROLEUM

Tree 41 Photo May 6

Crawford peach

Tree 47 Photo May 6

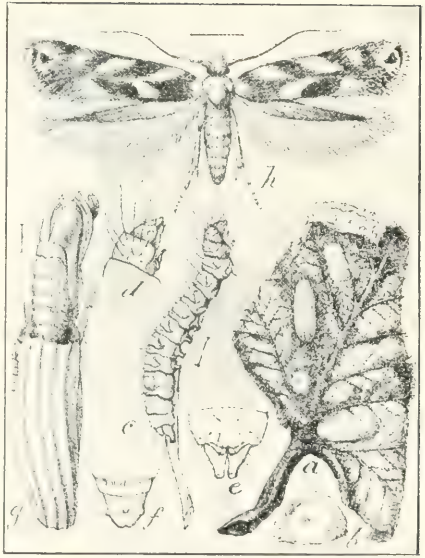
Old Mixon peach

1

Willow and poplar curculio

2

Nun moth



3

Birch Bucculatrix

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ENTOMOLOGY 18

AQUATIC INSECTS IN NEW YORK STATE

A study conducted at the entomologic field station, Ithaca N. Y. under the direction of
EPHRAIM PORTER FELT D.Sc.

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Bulletin 68

ENTOMOLOGY 18

AQUATIC INSECTS IN NEW YORK STATE

PREFACE

It is very gratifying to present the public with such a material addition to our knowledge of the aquatic insects of the State, an ecological group which has received almost no attention except from those engaged in a systematic study of the adults. There is no doubt that insects form an important part of the sustenance of some of our most valued food fishes, as shown by Dr Needham's studies of the food contents of trout stomachs. Mr Johannsen's systematic and biologic study of these minute species will do much toward making possible their identification in the immature as well as the adult condition. The ability to identify young or immature forms is exceedingly important when studying aquatic insects, and the great attention given to the early stages is the most valuable feature of this collection of papers. The publication of this bulletin marks another important step in an investigation on the value of insects as fish food. The consummation of this, as has been previously pointed out, is a work of years; and it is hoped that each season may be marked by substantial progress.

The acquisition of new facts is a laborious process; and the several authors are to be congratulated on their success.

This collection of papers will prove not only a source of information but also an inspiration to all subsequent workers.

E. P. FELT
State Entomologist

Part 1

STATION WORK OF THE SUMMER OF 1901

BY JAMES G. NEEDHAM

In 1901 the entomologic field station was conducted at Ithaca. The results of extensive field work at Saranac Inn the preceding season had not been fully worked up, and it seemed desirable that this unstudied material should be reported on. Thus access to collections and libraries became desirable; therefore, when Professor Comstock generously offered the station working quarters in his laboratory at Cornell University and the use of his library, his offer was gladly accepted.

A less ambitious program of field work was arranged for this second season. But, on the other hand, systematic studies of more importance and value, were planned and successfully carried out. The field work of the season was directed toward the study of nematocerous Diptera, aquatic Coleoptera and the aquatic neuropteroid groups. Breedings of Odonata-Zygoptera were carried on in order to supplement the extensive collections made at Saranac Inn in 1900, and to furnish a better basis for the account of that group in this bulletin. Not many additional species were reared, but much valuable material was obtained for some of the species there insufficiently studied. Trap lantern and other miscellaneous collecting was done through the season. In addition to the breedings of nematocerous Diptera, conducted by Mr O. A. Johannsen with great diligence and success, numerous Perlidae and Ephemeridae were reared by Mr Betten and myself. Collections of aquatic Coleoptera were also made, and these, together with my own breedings in that group, Mr. Mac Gillivray has worked up, generously adding thereto previous unpublished breedings of his own. His account of the group published herewith is destined to be highly useful to students of aquatic insects.

The chief feature of the station work of this season was cooperation. The station and the entomologic laboratory of Cornell University worked together most agreeably. Common

use was had of the equipment of both. In addition to the studies made for us by Mr MacGillivray, Professor Comstock assigned two of his graduate students, Mr O. A. Johannsen and Mr K. C. Davis, to work on special groups which the station was desirous of having investigated; and their work, published herewith, speaks for itself. This arrangement has made it possible to present now a larger body of work than the station independently, on its own limited resources, could have secured.

The station sacrificed nothing in natural advantages by removal to Ithaca. While so little is known of aquatic insects, the fauna of one place is about as new as that of another. For biologic field work of any sort, Ithaca possesses very great advantages. It would be hard to find a place with more variety of situation easily accessible. This is nature's contribution; and it is, of course, the first requisite of a field station. It rarely happens that so rich and varied a fauna and flora lie at the very doors of the laboratories in which their study may be most advantageously carried forward.

East hill, with the university campus spread out on one of its terraces, has cool swamps at its head and the Renwick flats and Cayuga lake at its foot, and is seamed all down its front by narrow gorges cut by turbulent streams. Across the narrow valley West hill rises with like abruptness; but it is of more regular contour, and its upper, gentler slopes are checkered by farms. Between the two hills at the head of the lake is a marshy flood plain, partly timbered, and traversed by sinuous creeks and bayous. Sheltered behind the present natural embankment of the lake is the Renwick lagoon, characteristic views of which are shown in plates 1, 2 and 20. This is a great natural aquarium, teeming with plant and animal life. It is also a natural foraging ground for many of the lake fishes.

The open lake is but a stone's throw to the northward, and the lagoon opens directly into one of the several nearby creeks. Plates 3 and 32 show situations along two of the creeks of East hill near the university campus and 600 feet above the lake level. These are pictures of collecting grounds utilized in gath-

ering material for the present report. They give but a scant idea of the great variety and picturesqueness of these streams. Within easy walking distance of the campus are streams of all degrees of swiftness and of all sizes from the large creek to the tiny rivulet. The two creeks that bound the campus on the north and on the south, flow gently in their upper reaches and again on the flats below, but they descend the steeps of East hill in a succession of cascades.

The workers at the station who were more or less directly participating in its operations were the following:

1 Professor C. Betten, of Buena Vista College, Ia., special collector of Trichoptera for the Cornell University collection. Rearing caddis flies and stone flies and running trap lanterns for the station.

2 Mr O. A. Johannsen of Cornell University, graduate student in entomology. Collecting and rearing nematocerous Diptera.

3 Mr A. D. MacGillivray, instructor in entomology in Cornell University. Studying aquatic Coleopterous larvae.

4 Mr H. N. Howland of Lake Forest College. Studying Odonata, and experimenting with apparatus for quantitative collecting of the insects of shore vegetation.

5 Mr H. D. Reed, instructor in vertebrate zoology in Cornell University. Collecting and studying aquatic insects and fish food.

6 Mr T. L. Hankinson of Cornell University. Studying and collecting the same.

7 Myself, in charge of station operations.

The excellent companionship of this body of enthusiastic students, the satisfactory and regular progress of daily routine, the fine facilities of the laboratory, the rich library, the accessibility of good collecting grounds, the suitableness of the equipment of the station, the beauty of the environment, and the weekly diversion of the meetings of the *Jugatae*[1] made the session one long to be remembered. Its work was done under exceptionally pleasant circumstances.

[1] Entomologic Club of Cornell University.

The results of our work in so far as made ready for publication appear in the following pages. With the aid of Messrs Reed and Hankinson, I have studied the food of the 25 brook trout taken in Bone pond at Saranac Inn, as detailed in my first report [N. Y. State Mus. Bul. 47, p. 396], and now report on it. The food of these trout was almost wholly insects, and there was found such a preponderance of a single species of gnat larva (family Chironomidae, order Diptera) in the food, as indicates that that species may prove of high economic importance in water culture. In another brief article I have brought together the descriptions of a few dipterous larvae of unusual types. Most interesting, perhaps, is the larva of Epiphragma fasciipennis, a burrower in fallen willow and buttonbush stems, lying on the banks of temporary ponds; a larva of enforced amphibious habits, its residence sometimes submerged, sometimes exposed; and it has a mode of respiration suited to either condition. My chief contribution to this bulletin is the description of the life histories and habits of the damsel flies (order Odonata, suborder Zygoptera). I have been able to describe the nymphs of all our 10 genera and of 23 of our 42 known species, all these descriptions being new.

Mr MacGillivray has prepared a table of families of coleopterous larvae in general that will be of great assistance to students of this order. His careful study of the respiratory apparatus of the Donacia larva solves the old, troublesome problem as to how that animal, dweller on the submerged roots of water plants, gets its air. His study of Donacia is complete for all species of the world fauna now known as larvae, and a considerable proportion of them are now described for the first time.

Mr Johannsen introduces his study of the dipterous families, Blepharoceridae, Simuliidae, Dixidae, Culicidae and Chironomidae, with a table of families of nematocerous diptera. His account of the Simuliidae is a monograph of the species of the eastern United States in all stages of their development. In the Dixidae he gives a key to our species (imagos) and offers the first life history written for an American species. His treat-

ment of Culicidae is a generic synopsis of the family—and much more; for he tabulates our known species of each genus, except Culex. His careful and complete treatment of the Corethriinae is specially gratifying because this subfamily has been neglected by other American students of Culicidae. In the Chironomidae, that Chironomus which is the chief article of diet for brook trout in Bone pond [*see* pt 2] is treated as completely as possible. Life histories are offered in two genera new to our fauna. This is but the beginning of Mr Johannsen's work on the Chironomidae.

Dr Davis's paper is a monograph of the Sialididae of America, and will be of great service to students of this neuropterous family, since it brings together descriptions of all known American species with an account of what is known of their life histories.

There remain, of station material still to be reported on, some Chironomidae and a large number of bred Perlidae and Ephemeridae.

Part 2

FOOD OF BROOK TROUT IN BONE POND

BY JAMES G. NEEDHAM

I have already given in New York State Museum bulletin 47, page 395-96, a brief statement of the conditions under which there were obtained from Bone pond during the summer of 1900 the stomach contents of 27 brook trout for study. These trout were all taken with hook and line. They were all adults and had selected their food in the natural way from what the pond offered.

The pond itself is a small natural body of water less than 300 meters in greatest diameter and nearly circular. It is without outlet and is surrounded by deep woods. I have given a brief sketch of its shore vegetation in bulletin 47 on page 389-90, with mention of the commoner animals collected there. It contains no fish but the brook trout. It was artificially stocked years ago, and has been repeatedly replanted with fry. Of the three propagating ponds controlled by the Adirondack Hatchery, it is by far the most successful in trout production. From the beginning the trout have been able to maintain themselves

in large numbers. Most of the trout I saw taken from it in 1900 were rather lean, though otherwise in good and healthy condition, and suggested that possibly it was becoming overstocked.

Of the 27 stomachs obtained, one was empty, and the contents of another were lost through the breaking of a bottle, leaving 25 for study. I give below in tabular form a bare statement of what these 25 had eaten, and follow it with an account of what has been learned elsewhere of the biology of the insects constituting their food.

Table showing the stomach contents of 25 brook trout from Bone pond

Number	Date	Chironomus sp.? larva	Chironomus sp.? pupa	Corethra sp.? larva	Corethra sp.? pupa	Trichopter larva	Trichopter pupa	Trichopter cases	Aeschna constricta	Callibaetis sp.? nymph	Atax crassipes	Daphnidae	Miscellaneous
1	28 July	6	....	....	3	....	....	....	....	....	2	.....	....
2	30 "	124	....	5	2	1	....	11	....	1	....	.....	....
3	3 Aug.	14	2	....	....	2	....	44	....	....	....	.....	....
4	3 "	7	....	....	....	....	....	....	....	....	....	.....	....
5	3 "	235	....	42	....	....	....	....	....	....	....	fragments	....
6	3 "	313	1	....	20	1	....	1	....	....	....	.....	....
7	3 "	15	340	....	....	2	....	5	....	....	....	.....	*a*
8	3 "	77	2	5	....	....	....	....	....	1	....	.....	....
9	3 "	7	....	1	12	1	....	5	....	....	....	.....	*b*
10	3 "	114	....	1	3	....	....	....	1	....	....	.....	....
11	3 "	36	32	3	2	....	....	....	....	....	....	.....	*c*
12	3 "	9	1	1	....	....	....	....	....	....	....	.....	....
13	3 "	2	....	1	4	....	....	....	....	1	....	.....	....
14	3 "	5	58	....	....	....	3	....	....	....	1	.....	*d*
15	3 "	351	....	....	4	....	1	....	....	....	....	.....	....
16	3 "	.....	....	....	....	1	....	....	....	2	....	.....	....
17	3 "	12	....	....	27	2	....	10	....	....	4	250	*e*
18	3 "	30	8	3	9	....	....	....	....	....	....	.....	*f*
19	3 "	.....	....	....	1	....	....	....	....	1	....	.....	....
20	8 "	.....	....	....	....	....	....	....	....	1	....	.....	....
21	8 "	174	....	1	....	....	....	....	1	....	....	.....	....
22	15 "	245	....	....	4	....	....	....	....	....	....	.....	*g*
23	15 "	310	....	1	1	....	....	....	....	....	....	.....	....
24	18 "	132	....	....	....	....	....	....	....	....	....	.....	....
25	18 "	244	....	....	....	....	....	1	....	....	1	.....	....
	Total..	2462	444	64	92	10	4	77	2	7	8	250	....

a A few brook trout scales.
b One little fresh-water mussel.
c Antenna of adult ♂ chironomid of small size.
d Carabid beetle claw.
e Scolytid beetle elytron and two little adult Chironomids.
f Achorutes sp.? (Order Thysanura).
g Three little adult Chironomids.

In this table the food species have been arranged in what seemed to be the order of their importance as constituents of the food of the trout at the time and place taken. The totals, counting larvae and pupae of a species together, are 2906 Chironomus, 156 Corethra, 14 trichopter larvae, 2 nymphs of Aeschna constricta, 7 nymphs of Callibaetis, 8 Atax crassipes, 250 (approximately) Daphnidae, and a few wholly unimportant things listed as miscellanies. The numerical ratio of these is 116.24 Chironomus, 6.24 Corethra, 10 Daphnidae, .56 trichopter larvae, .32 Atax, .28 Callibaetis, .08 Aeschna to each of the 25 trout. What may be the relative food value of these species is, of course, wholly undetermined. In arranging them in the foregoing table, I have taken into account only their relative size. I should be inclined to regard only the three first named in the table as of any considerable importance to the trout.

To my mind the chief value of this table is that it clearly indicates one species of economic importance to trout culture—the Chironomid of whose larvae and pupae an average of 116 specimens had been eaten by each trout. The largest number eaten by a single trout was 351, while three trout had eaten none at all. It is possibly significant, possibly only accidental, that the May fly nymphs were eaten chiefly by those trout that had found no Chironomids.

NOTES ON THE FOOD SPECIES OF THE TABLE

1 Chironomus sp.?

There can be no doubt that in Bone pond this is an exceedingly important species. Unfortunately, the day this fact became apparent, in the cursory examination of the food as taken from the stomachs, was the last day of study permitted us at the pond. What the species is, consequently remains unknown. Mr Johannsen has studied the larva and pupa systematically, and has treated them in part 3. His figures [pl. 49] should make the recognition of the species possible when other larvae shall have been obtained and bred.

Professor Forbes in his studies of Illinois fishes (the brook trout was not one of the fishes he studied), has clearly pointed out the importance of these small larvae as fish food: "Among aquatic insects, minute slender dipterous larvae, belonging mostly to Chironomus, Corethra and allied genera, are of remarkable importance, making, in fact, nearly one tenth of the food of all the fishes studied."[1] In his report[2] on the aquatic invertebrate fauna of the Yellowstone national park, almost every page testifies to the abundance, general distribution and ecological importance of Chironomus. On page 228 are given some observations indicating that it is of as great importance to young trout as to adults:

The pond was swarming with mountain trout (Salmo mykiss), a few of which I dissected for a determination of their food. One of these an inch and a half in length had eaten Chironomus larvae and imagos chiefly, the remainder of its latest meal consisting of other insect larvae, not in condition to identify, and the entomostrachan Polyphemus pediculus. A second, an inch and a quarter long, had also fed on Chironomus in its various stages of larva, pupa and imago, but had made about a third of its meal of Entomostraca. Another, still smaller (.92 of an inch long) taken from the open lake among the small weeds growing on a flat, muddy rock, had filled itself with Chironomus pupae only, as had still another of the same size. A third specimen from this situation had eaten more larvae of Simulium than of Chironomus, and a fourth had also eaten Simulium larva and another dipterous larva unknown to me. I may add here that other young trout, in a small swift rivulet near the Lake hotel, were feeding continuously, Aug. 9, on floating winged insects, mostly, if not all, Chironomus and smaller gnatlike forms.

With these certain indications of the economic importance of the genus at hand, it is indeed time we were able to recognize its species. Mr Johannsen's work in part 3 is a beginning in that direction. All the above mentioned references, as well as most others to immature stages wherever published, are to the genus only; and Chironomus is a great genus, and includes forms with considerable diversity of structure, habitat and

[1] Ill. State Lab. Nat. Hist. Bul. 2, p.483.
[2] U. S. Fish Com. Bul. 11, p.207-56.

habits. It is quite probable that with pond culture, as with agriculture, when real progress begins it will be necessary to recognize not only species, but also varieties of the more important species.[1]

Notwithstanding the indefiniteness of our knowledge concerning Chironomus as a whole, it may be worth while to venture some general observations concerning the habits of the genus, since these will explain some peculiarities of the table. Among the larvae attributed to the genus there is considerable diversity of structure, and a very striking range of color. Color differences have led to the distinction "white larvae" and "red larvae" in such papers as the one above quoted. The distinction is arbitrary, however, and of very limited applicability. The range of color is continuous from bright crimson in some of the red larvae to translucent pale yellowish or greenish in the others. Moreover, all are "white larvae" when newly hatched; and the red color is correlated with a considerable increase in size without a corresponding development of the tracheal system in the body, and is due to the increase of hemoglobin in the blood plasma. In general, it may be said that the "red larvae" are larger, have a more extensive development of blood gills, and live in deeper or less well aerated water; the "white larvae," most of which are not Chironomus in the stricter sense, are as a rule smaller, have little development of blood gills or of hemoglobin in the blood plasma, and live in rapids, on shore vegetation in shallower, cleaner, better aerated water.

The Chironomus of the foregoing table is one of the larger species, with larvae of bright red color. Many of them were alive when taken from the trout stomachs, and wriggled about as actively as if just taken from the water. In shore collecting none were found, but a few of their loose, flocculent gelatinous cases were found at the farthest reach of a long handled net (depth 5-6 feet). The species is doubtless a denizen of the deeper water, which is the proper feeding ground of the trout. It lives

[1] Several British species are characterized in their immature stages, and a good general introduction to the study of the biology of the genus is now available in Miall & Hammond's *The Harlequin Fly*, Oxford 1900.

on the bottom in the midst of a very thin layer of silt and vegetable debris covering the white sand. Its loose gelatinous case is covered with adherent silt, and takes on the general, protective color of the bottom. As is well known, the larvae of the larger red species are among the most characteristic bottom forms in all our larger and deeper lakes, being usually associated with deep water mollusks (Pisidium) and caddis fly larvae. This distribution, the natural abundance of the larvae, and the constant succession of generations through the year, leaving no period of absence of the larvae from the water, constitute the claim of these larvae to economic importance.

The pupae at first are red, but that color is generally quickly obscured by the development of the pigment of the adult insect. Within a few days at most after the transformation from the larva, the pupa rises to the surface and floats there, descending when disturbed, but quickly rising again. Pupae are less uniformly distributed over the surface than are larvae over the bottom, for the wind may drive them together in great masses. Pupae are often taken in numbers in a surface net in towing; larvae are rarely taken so, and then only at night, and in shallow water, for the larvae often leave their retreats at night and go swimming considerable distances with figure-of-eight loopings of the body.

It will be seen in the table that, with the exception of trout 11, every trout that had eaten Chironomus at all had eaten either larvae or pupae largely in excess; a large number of one stage, few or none of the other. In the light of the differences in habits of larvae and pupae just stated, this should indicate that some of the fish had been feeding chiefly or wholly at the bottom, others at the surface of the pond. The larger number of larvae eaten may indicate either that larvae were more easily obtained, or that they were preferred, or that bottom feeding was preferred.

2 Corethra

This is another form that is common in our northern lakes generally. It was not studied at Bone pond, and was collected there only by the trout. *Corethra plumicornis* is

common in a pond on the campus at Lake Forest, and there I have observed its habits for several years.

The larvae are free swimming and are found most abundantly beyond the line of the shore vegetation. They are entirely transparent, except for two pairs of air sacs and some pigment in the eyes, and, generally, food in the alimentary canal, appearing as a dark line through the middle of the body. Their transparency doubtless secures them some immunity from enemies. I have experimented with feeding them to a hungry nymph of a dragon fly Libellula pulchella. Placed in the nymph's mouth, they were eaten with avidity, but, placed thickly in the water with it and swimming around within easy reach, none were captured or even reached after by the nymph. It was probably unable to see them, for it quickly seized water boatmen (Corisa) when substituted for the Corethra larvae. I very much doubt whether the trout can see them. If they are as abundant in Bone pond as they often are in my campus pond, even the considerable number shown in the table, might, I think, have been taken in the straining of the water through the gill rakers, without selection of any individuals for capture.

The pupae of Corethra are at first likewise transparent and free swimming, but soon rise to the surface and float there, like Chironomus, and just before transformation, become darker colored. The imagos settle on low vegetation around the borders of the water, or rise, dancing in swarms in sheltered and sunny places. The females deposit the eggs on the surface of the water, laying them down flatwise, in a spiral held together by scanty gelatine.

Among insects these larvae are the most independent of the shore vegetation. They feed on free swimming unicellular plants and animals. In my campus pond during April and May (the months of my observation) they live chiefly on a species of Peridinium, with a sprinkling of other flagellate infusorians. Specimens taken freshly from the pond generally show a distinct brown streak through the middle of the body, due to the Peridinia eaten. They are not incapable of disposing of much

larger prey, however. Very frequently in my aquariums, after the supply of other food has run out, I have found a larva, with another larva of its own species and nearly of its own size, two thirds swallowed and one third digested.

We have but few species of Corethra, and they are much alike, and should be readily recognized generically in larval and pupal stages by comparison with the figures given on plate 39.

3 Unknown trichopter larva from bottom of Bone pond

This is another species that lives outside the line of the shore vegetation. Just outside that line, on bottoms shallow enough to be reached with a long handled sieve net, Mr Betten found the cases of the species in great abundance, but they were all empty. He has described the case in bulletin 47, page 572, as no. 2.

Because all students of our lake bottoms have reported caddis fly larvae along with Chironomus larvae as a constant part of the fauna, I have thought it desirable to have the structural characters of this species illustrated as fully as possible in the hope of its recognition by comparison in the future. The only specimens seen were obtained from the trout stomachs, and were pretty well digested. Some of the cases were fairly well preserved, but the pupae were so badly disintegrated as to be hardly distinguishable as pupae; the parts of the larvae most strongly chitinized, and the parts most important for the distinguishing of the species were fairly well preserved, and have been used, together with a perfect case collected from the water and apparently belonging to the same species, as a basis for the figures presented on plate 6.

The trout swallow the animals case and all, doubtless being unable to get them apart. The case persists after the animal within has been disintegrated, but the sand grains gradually fall off, and the brown, lining tube of silk gradually breaks up into fragments. Most of the stomachs contained a little sand, doubtless derived from this source, and trout nos. 2, 3, 6, 7 and 17 contained large quantities loose, in addition to that still on the walls of the cases remaining.

4 Aeschna constricta

The nymphs of this dragon fly live in the midst of the shore vegetation in shallow water. The trout that eat them probably have to go beyond the confines of their usual feeding grounds to get them. The advanced stage of digestion in which the specimens were found seemed to indicate that the specimens had been taken during the preceding night. Aeschna nymphs attached to a hook were taken by the trout, but not more readily than minnows, small frogs or other bait.

These were the largest animals the trout had eaten. The volume of one of them would equal perhaps that of 15 to 20 Chironomous larvae, or 30 to 40 Corethra larvae, or 5 to 7 caddis fly larvae, or 4 to 5 Callibaetis nymphs. They are among the most powerful members of the aquatic insect community and clamber about frequently on exposed places on plant stems, where the trout, if at hand, might easily seize them.

In a small way the dragon fly nymphs are competitors of the trout for food. They eat small insects promiscuously, and doubtless many pupae of Chironomus and Corethra fall victims to them. They will eat young trout, also, as long as themselves. I demonstrated this at Saranac Inn by confining them together in a breeding cage. One little trout would be captured quickly, and then the others would be wary of the nymphs and keep away from them well, so that we would think they would evade a similar fate, but one by one they would disappear till all had been eaten. The Aeschna nymph approaches its prey with the slowness and poise and stealth of a cat till within striking distance. Plate 5, figure B, shows a nymph of this species poising for a stroke at a backswimmer (Notonecta).

The adult dragon fly is shown also on this plate. Transformation occurs in the latter part of June and in July. The female inserts her eggs by means of an ovipositor into the stems of plants just below the surface of the water. The eggs hatch in about three weeks, and the little nymphs at once take up their abode among the submerged plants and eat promiscuously any other animals they can overpower; they also eat one another.

I have not been able to determine as yet whether in relation to trout culture Aeschna is more disadvantageous than otherwise. It eats a few of the fry and it eats the food of the larger trout; but, on the other hand, it furnishes a moderate supply of food itself for the larger trout.

Out in the proper foraging ground of the trout, burrowing shallowly under the silt of the bottom of the pond, are other dragon fly nymphs of the genus Gomphus, which would seem to be wholly detrimental. They feed voraciously on other insects of the bottom fauna, and, doubtless, on Chironomus larvae, while by their burrowing habits they seem to escape the trout altogether.

5 Callibaetis sp.?

These nymphs, like the preceding, were found in an advanced stage of digestion. That they were Callibaetis, however, was determinable from the structure of the jaws, the top of the thorax and the bases of the setae, which were preserved. Since no adult May flies were collected at the pond and no nymphs bred, what the species is could not be established. Callibaetis ferrugina was taken at the hatchery, and the nymphs may very well have belonged to this species.[1]

This is a large genus, peculiar to the new world. A considerable number of species are already described, and doubtless many more will yet be discovered. I have found the nymphs exceedingly abundant in many small lakes and ponds. They are most abundant amid the shore vegetation, but wander out into deeper water, resting on the bottom, and darting rapidly from place to place. I think it likely that they will be found more important as the food of young fishes than of adults, because of their greater abundance in the shallower water.

It is due to the occurrence of a new species of Callibaetis in my campus pond at Lake Forest, where, with my students, I have watched it year by year, that I am able to give some facts respecting the genus, which have a bearing on its economic

[1] While this is going through the press there comes to my table a description of the nymph of this species with figures by Berry, in the *American Naturalist*. 1903. 37:29, 30.

status. The nymphs are associated with Corethra larvae, and, like them, are generally in excessive abundance at all seasons of the year. Unlike the better known May flies, this species has no single period of transformation; but imagos may be found beside the pond most of the time from April till September. There are, to be sure, as with Corethra, a larger number in evidence at the beginning of their season, about the middle of May, than at any time thereafter, but that, I think, is due to the cold weather retarding the process of transformation more than it retards growth. I have found the imagos quite abundant in September. This repetition and overlapping of generations makes for continuity of food supply in the water.

The nymphs at transformation climb up only to the surface on some support, and then leave their cast skins floating on the water. The subimago stage lasts about 24 hours and is spent, as is usual, inactively. The male imagos are much in evidence, flying in little flocks in sheltered places in the sunshine, weaving up and down in their peculiar, rapid, dancing flight, and scattering on the approach of a net and settling on the reeds so quickly and sitting so quietly that they usually entirely disappear from view. I have found it difficult to capture many specimens of this species, even when they are abundant. The females are very seclusive. I have rarely found one flying with the males, or been able to discover one resting on shore. They are frequently seen floating on the surface of the pond, resting on the water with wings outspread, in which manner, like many other species of May flies, they deposit their eggs.

I append a description of this species in both adult and nymphal stages. The accompanying figures will suffice for the recognition of the genus. The adults of the genus are recognizable by the costal band of brown on the wings, best marked in the female, and the generic characters of the nymphs are stated in the table for the genera of May fly nymphs given in bulletin 47 on page 419.

Callibaetis skokiana n. sp.

Plate 7

Imago. Length of body 9–10mm; expanse of wings 18–20mm; length of setae, male 20mm, female 16mm. Ground color pale flesh tint, tinged with yellow (more yellowish in the female), marked, mottled and dotted with brown; antennae, legs and setae white.

Head pale brownish, with whitish margins; in the male occupied superiorly by the large turbinate superior portion of the compound eyes, which are pale egg yellow on their superior, faceted surface, with paler margins, and which are as large as all the remainder of the head; in the female the top of the head is very flat, and is traversed by two longitudinal, irregular, pale brown bands, which are surrounded and separated by whitish.

Prothorax paler, thickly dotted with brownish color. Dorsum of the mesothorax with a pale, longitudinal median suture, each

Fig. 1 Wings of Callibaetis skokiana, male

side of which is a band of brown rounded off posteriorly, and at the sides there are brown spots inferiorly. The median narrow pale line is continued posteriorly to the abdomen, and there are brown spots on the sides of the metanotum. Sides of thorax irregularly speckled with brown. Legs white with darker markings at the knees and at the ends of the tarsal segments, the last one of which is wholly washed with brown. Wings with the usual costal band, differing in the sexes, behind which they are hyaline. The band in the female is darker and better developed. It covers proximally the bases of all the veins and is regularly narrowed to the apex, ending just before the apex of the wing, not lobed posteriorly, fenestrate with hyaline on most of the cross veins except toward the base, and reduced to a yellowish wash in the stigmatic region and about the humeral cross vein. In the male the costal fascia is paler, and usually disappears just before the yellowish stigmatic space, which is sometimes filled with anastomosing cross veins. The venation of the male is shown in figure 1. There is much variability in the

number of cross veins in any part, but in general they are more numerous in the female. Behind the costal brown band in the female there are about 70 cross veins, not in a single row, not in regular rows at all.

Abdomen pale yellowish or flesh tinted, thickly dotted and dashed with brown, tending to form a dark middorsal band, more or less completely divided on the base of each segment, a line of brown dashes each side just above the pale lateral margin on segments 1-9, with a more or less separate curved mark above the anterior end of each dash. At the sides the metathorax overlaps the first abdominal segment and almost reaches the base of segment 2. The ventral side of the abdomen is paler with more uniform dots and a pair of submedian brown C– marks

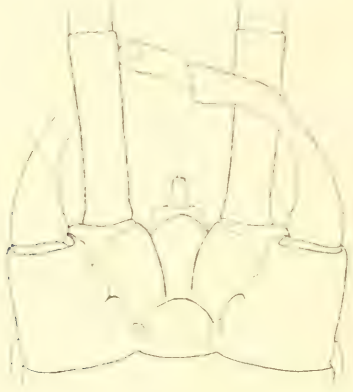

Fig. 2 End of abdomen of Callibaetis skokiana, male, ventral view, showing forceps, rudimentary median caudal filament and bases of lateral filaments

on segments 2–9, abbreviated on segment 9. Forceps of the male [figure 2] and setae of both sexes pure white.

Subimago. Differs in having the setae shorter (about 9mm long in both sexes), the wings faintly smoky brown, or slightly tinged with yellowish on the middle of what is to be the costal band, and the principal bands of brown on the body faintly indicated.

Nymph. Length of body 12–13mm, setae 6–7mm additional; width of head 1.2mm, of thorax 1.8mm. Color greenish, marked with pale fuscous.

Head pale, suffused with brownish around the eyes and across the ocelli in front, a longitudinal band bounding each eye internally, tinged with yellowish.

Prothorax pale marked with fuscous on the front margin and at the sides, with a pair of pale spots in irregularly contoured brown inclosures on the dorsum. Mesothorax and metathorax darker dorsally with pale markings at the front margin and at

the rear between the wings; brown spots on the base and in the furrows of the wings. Legs pale, smooth, somewhat infuscated on the tarsi.

Abdomen with a median dorsal interrupted band of brown, preceded by an urceolate divided brown mark on the metathoracic dorsum, furcate anteriorly on segment 1 of abdomen, broadly overspreading segments 2 and 3 with additional brown spots at the sides and divided by peler apically; reduced to a slender T-mark on 4, the T-mark and lateral spots reappearing on 5, the T-mark joined to an apical transverse line on 6, and on 7, fused with the lateral spots, a median line with lateral U-marks on 8 and 9, 10 with the line and the margins narrowly (the apical margin more broadly) fuscous.

Gills on segments 1-7, on 7 simple, and almost symmetric, a slightly indicated basal lobe on the posterior side, on 6, 5, 4 and 3 this basal lobe is successively more pronounced, becoming separated by a deep notch on 3; on 2 and 1 this lobe becomes a third as large as the body of the gill under which it is then folded, and a shallow incision appears on the anterior side of the body of the gill, nearer apex than base. All gills erect, with tracheae pinnately branched. The setae are pale with a wash of darker color near the tip.

Other items in the food

The eight water mites, Atax crassipes Müll., found in the food may well have been taken accidentally, as they are so small they could scarcely have been taken otherwise.

The large number of Daphnidae found in a single stomach is a peculiarity for which I have no explanation to suggest. They were in an advanced state of digestion, and the number given is only approximate. There were fragments of what I took to be Daphniae in the stomach of trout 5 also, but scarcely recognizable. The difficulty of recognizing and counting these was quite in contrast to the ease and certainty with which the same things were done for the other food constituents. The heads of Chironomus and Corethra were most distinctive, and were the parts longest resisting digestion, so that among a mass of fragments it was only necessary to count the heads.

The items listed as miscellanies were doubtless all accidental and unimportant. I think that the trout scales found did not indicate that any trout had been eaten, but only that they had been fighting, and this one had bitten another deeply enough to loosen a bit of its cuticle.

Part 3

LIFE HISTORIES OF ODONATA

SUBORDER ZYGOPTERA

Damsel flies

BY JAMES G. NEEDHAM

The discussion of this suborder here is to be regarded as a continuation of the study of the order from Museum bulletin 47, wherein the suborder Anisoptera was treated, and 62 life histories were detailed. Only the fauna of the State is discussed, and the bibliographic notes have here the same limited scope and purpose. No descriptions of imagos are given, but the reader is referred to well known descriptive catalogues, and it is hoped that the keys to imagos given herewith, together with the figures, may prove sufficient for the determination of our species. My purpose has been to make known the immature stages, and to that end, nymphs of all the species whose life histories are known are newly described.

In the suborder Zygoptera 38 species have been listed from New York State hitherto: 36 by Calvert[1] and two additional by Davis.[2] To this number we are able to add four species: Lestes vigilax from Cold Spring Harbor L. I.; Enallagma piscinarium and E. pollutum from Ithaca and Nehallennia gracilis from Saranac Inn. Of the 42 species thus known from the State, we have reared 23, and describe herewith, in more or less detail, their nymphs. All these descriptions are new, and apparently the first that have been written for our species though Hagen[3] has briefly stated the group characters of our genera of Calopterygidae. Of these 23, three are Calopterygidae, five are Lestinae and the remaining 15 are Agrioninae: and, fortunately, the nymphs of all our genera are now known.

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[1] Thirty-five in his Odonata of New York State. N. Y. Ent. Soc. Jour. 3:39-48 and 5:91-96 and one in Ent. News. 12:326.

[2] Preliminary List of the Dragon Flies of Staten Island. N. Y. Ent. Soc. Jour. 6:195-98.

[3] Essai d'un Synopsis des Larves des Calopterygines. C. R. Ent. Soc. Belg. 1880. 23:65-67.

In view of the fact that the nymphs of about half our species, including some of the commonest, are still unknown, a word to the collector, additional to what has been said in Bulletin 47, will be in order here. The Zygoptera are very easily reared. Nymphs taken when grown will transform readily in any sort of aquarium containing plant stems for them to climb on. Males should be bred for certain determination; and the male imago when well colored should be placed at once with its cast skin in a vial of 70% alcohol and promptly labeled.

But, unlike most Anisoptera, the Zygoptera transform commonly in the daytime; and it thus becomes a very easy matter at the right time to pick up life history material. At the time when any species known to be locally common is just beginning to appear on the wing, one may go to its aquatic haunts, expecting to find with a little searching nymphs on stems near the surface of the water, others crawling out or transforming, imagos beside their recently abandoned nymph skins and teneral imagos taking flight. At this time it will not do to assume that all that look alike are the same species. Owing to the exceedingly close likeness of many of the species in such genera as Lestes, Argia and Enallagma, one must select males for certain determination, must keep each imago with its own cast nymphal skin, and must keep the imago alive till the form of the appendages and the color pattern are fully developed. This last point is readily secured by placing the imago and skin when newly transformed in a paper bag for 24 hours, closing the top and avoiding undue jostling about at first.

KEY TO FAMILIES AND SUBFAMILIES OF ZYGOPTERA

Imagos

a Quadrangle [*see* fig.8] of the wings divided by a number of cross veins; antenodal cross veins numerous; pterostigma lacking a special brace vein; wings rather broad..... Calopterygidae

aa Quadrangle without cross veins; antenodal cross veins but two in each wing; pterostigma with a brace vein at its proximal end in the space behind vein R_1; wings narrower..... Agrionidae

b Vein M_3 arising (i. e. separating from vein $M_{1,2}$) nearer the arculus than the nodus..... Lestinae
bb Vein M_3 arising nearer the nodus than the arculus..... Agrioninae

Nymphs

a Basal segment of the antenna very large, as long as the other six together; median lobe of the labium with a very deep cleft; gills thick, the lateral ones triquetral.....Calopterygidae
aa Basal segment of antenna not longer than succeeding single segments; labium with a very shallow closed median cleft or no cleft at all; gills thin, lamelliform..... Agrionidae
b Median lobe of labium with a short, closed, median cleft; lateral lobe trifid at end; movable hook bearing raptorial setae; gills showing transverse segmentation..... Lestinae
bb Median lobe of labium entire; lateral lobe bifid at end; hook naked; gills various..... Agrioninae

Family CALOPTERYGIDAE

This family includes in our fauna but two genera, Calopteryx and Hetaerina, both of which frequent strong flowing, permanent streams. The long legged, protectively colored, rather stiff and awkward nymphs cling to submerged vegetation, generally where it is washed by the current of the stream.

KEY TO GENERA

Imagos

a Basal space (space before the arculus) in all wings free from cross veins.....Calopteryx
aa Basal space of all wings traversed by cross veins..... Hetaerina

Nymphs

a Median cleft of the labium extending far below the level of the base of the lateral lobes; abdomen without lateral spines; dorsum of prothorax rounded at the sides .....Calopteryx
aa Cleft of the medium lobe of the labium extending only to the level of the base of the lateral lobes; lateral margins of abdominal segments 7-9 generally ending in small, flattened lateral spines; dorsum of the prothorax with two angulate teeth each side..... Hetaerina

CALOPTERYX

This strongly marked genus is abundantly represented about the borders of creeks and small rivers throughout the State, specially where such streams traverse rocky woods. The showy imagos, with their black or smoky wings, and bodies of brilliant metallic green, are very conspicuous, and well known insects. They usually remain in proximity to their native streams, but sometimes follow paths for a considerable distance through adjacent woods. Their flight is poor and fluttering, and on windy or cloudy days they keep rather closely to shelter. The

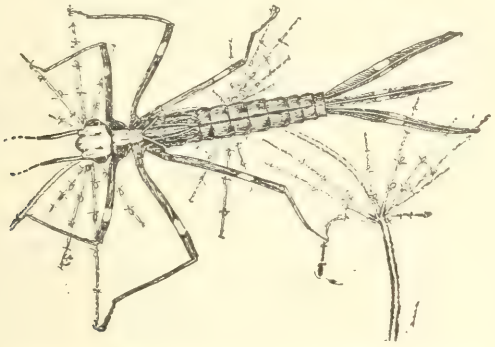


Fig. 3 Nymph of Calopteryx maculata

nymphs rest on silt-covered vegetation or on roots swaying in the current, and are rather inactive, moving but little from place to place.

The known nymphs agree in the possession of long cylindric bodies, heads dorsally depressed, antennae with unusually developed basal segment, exceeding in length all the other segments put together, labium with a median cleft which divides the median lobe far below the level of the bases of the lateral lobes, a pair of spinules beside the cleft within, and three others at the base of each lateral lobe, legs long and thin, radiately arranged, gills three, variable in proportions, but always stout, the lateral pair with external carina, the middle one two-edged, all easily broken off, and generally wanting from specimens that have received too rough treatment.

KEY TO SPECIES

Imagos

a Wings narrow; hind margin straight for a distance, and parallel to front margin
b Wings uniformly colored or transparent
c Wings clear ..... angustipennis
cc Wings yellowish ..... amata
bb Apical sixth of wings black ..... apicalis
aa Wings dilated, with hind margin visibly rounded
b Apical third of the hind wings blackish ..... aequabilis
bb Wings uniformly blackish or smoky ..... maculata

Nymphs

a Basal segment of the antenna one third longer than the head is wide ..... aequabilis
aa Basal segment of the antenna hardly longer than the head is wide ..... maculata
aaa Unknown ..... angustipennis, amata, apicalis

Calopteryx angustipennis Selys

1853 Sylphis angustipennis Selys, Acad. Belg. Bul. 20:9
1854 Sylphis elegans Hagen, Monogr. Calopterygines, p.23. ♀.
1861 Calopteryx angustipennis Hagen, Synopsis Neur. N. Am. p.56
1875 Calopteryx angustipennis Hagen, Bost. Soc. Nat. Hist. Proc. 18:20 (full bibliography and notes)
1889 Calopteryx angustipennis Hagen, Psyche, 5:242 (description)
1900 Calopteryx angustipennis Williamson, Dragon Flies Ind. p.253 (description and account of habits)

This elegant, clear winged species has not been found as yet within the State, but Mr Williamson has found it locally abundant in western Pennsylvania. Its nymph is unknown.

Calopteryx amata Hagen

1889 Calopteryx amata Hagen, Psyche, 5:242 (original description)
1895 Calopteryx amata Calvert, N. Y. Ent. Soc. Jour. 3:42 (listed from Keene Valley: descriptive notes)

To the above record of a single capture of this species at Keene Valley, I have only to add the record of another capture on the other side of the Adirondacks, at Axton in June 1901, by Mr A. D. MacGillivray. The nymph is unknown.

Calopteryx apicalis Burmeister

1839 Calopteryx apicalis Burmeister, Handb. Ent. 2:826 (original description)
1861 Calopteryx apicalis Hagen, Synopsis Neur. N. Am. p.56 (description)
1875 Calopteryx apicalis Hagen, Bost. Soc. Nat. Hist. Proc. 18:21 (bibliography and distribution)
1889 Calopteryx apicalis Hagen, Psyche, 5:246 (a full description)
1893 Calopteryx dimidiata, race apicalis Calvert, Am. Ent. Soc. Trans. 20:228
1895 Calopteryx dimidiata, race apicalis Calvert, N. Y. Ent. Soc. Jour. 3:42 (listed from Westchester county)
1900 Calopteryx dimidiata, race apicalis Williamson, Dragon Flies Ind. p.253 (description)

This southward ranging species seems likely to be met with only at the lower altitudes in the southern parts of the State. Its nymph is unknown.

Calopteryx aequabilis Say

1839 Calopteryx aequabilis Say, Acad. Nat. Sci. Phila. Jour. 8:23
1861 Calopteryx aequabilis Hagen, Synopsis Neur. N. Am. p.58
1875 Calopteryx aequabilis Hagen, Bost. Soc. Nat. Hist. Proc. 18:21 (bibliography and distribution)
1889 Calopteryx aequabilis Hagen, Psyche, 5:246 (full description)
1899 Calopteryx aequabilis Kellicott, Odon. Ohio, p.9 (description)
1900 Calopteryx aequabilis Williamson, Dragon Flies Ind. p.252 (description)
1895 Calopteryx aequabilis Calvert, N. Y. Ent. Soc. Jour. 3:42 (listed from Keeseville)

This species is common near Axton along Stony brook and Raquette river. At Saranac Inn, 15 miles farther north, but two or three specimens were taken during the entire season. On July 31, 1900 Mr Betten and Mr Swett made a special trip down to Axton to get its nymph. All the specimens they brought back to Saranac Inn were kept there till the close of the season of our work, but failed to transform. They showed however a greater length of basal segment of antennae than the nymphs of C. maculata found at Saranac Inn, and have therefore been referred by supposition to C. aequabilis. By way of de-

scription I will give the measurements of one of the largest nymphs, (length 23mm, antennae 5mm and gills 13.5mm additional) and add that the nymph seems entirely like that of C. maculata except in its more uniform coloration and in the diagnostic character already stated in the key.

Calopteryx maculata Beauvois

The blackwing

Plate 11

1805 Agrion maculata Beauvois, Ins. Afr. Am. p.85, Neur. pl.7, fig.3
1861 Calopteryx maculata Hagen, Synopsis Neur. N. Am. p.57
1875 Calopteryx maculata Hagen, Bost. Soc. Nat. Hist. Proc. 18:22
1889 Calopteryx maculata Hagen, Psyche, 5:246 (full description)
1893 Calopteryx maculata Calvert, Am. Ent. Soc. Trans. 20:227 (description)
1895-97 Calopteryx maculata Calvert, N. Y. Ent. Soc. Jour. 3:41 and 5:92 (listed from many localities in the State)
1899 Calopteryx maculata Kellicott, Odon. Ohio, p.8 (description)
1900 Calopteryx maculata Williamson, Dragon Flies Ind. p.251 (description)

This is our common species. In early summer it may be observed poising on some green twig beside any clear stream, or lending animation to the scene by the show of its brilliant colors in flight. At this season the cast skins may be looked for along any bank near which the imagos are flying, sticking fast to some support in a sprawling attitude close to the surface of the water.

Nymph [fig.3]. Length 20mm, antennae 4mm and gills 11mm additional, 35mm in all.

Elongate, slender, smooth; greenish brown, with a broad band of paler color nearly covering the flat upper surface of the head, and tapering backward on the thorax; paler rings on the middle of femora and gills; obsolete band of darker brown on the sides of the body, best defined on the sides of the thorax and rear of the head; a middorsal line of brown on the abdomen, interrupted at the sutures; gills usually paler at extreme tip.

Labium [pl.14, fig.*a*] elongate, reaching posteriorly between the bases of the middle legs; no raptorial setae, but a spinule each side of the deep median cleft within, and three others at

the base of each lateral lobe. Movable hook strong, arcuate. Distal end of lateral lobe divided.

Legs long, slender, smooth; no lateral carinae or spines on the abdomen; wings reaching the middle of the fourth segment; gills thick, with smooth and not very sharp carinae.

In half grown specimens femora, tibiae and gills are often distinctly triple banded with brown, and the median cleft of the labium extends hardly below the level of the bases of the lateral lobes.

The females descend on stems of more or less completely submerged aquatic plants (such as Elodea), and, unattended by the males, insert their eggs thickly into the green stems, just below the surface of the water.

HETAERINA

This genus includes some of the most beautiful of insects. It is abundantly represented in the tropical parts of America; but for our State a single species is recorded. Another species which occurs in Pennsylvania may yet be discovered within our borders.

The common northern species, H. a m e r i c a n a [pl.12], frequents slow flowing streams. The imagos are on the wing in late summer and early autumn, flitting about the borders of riffles. The males are very showy, and are easily distinguished from all our other dragon flies by the presence of a bright crimson streak on the base of each wing. Though their flight seems rather fluttering and uncertain, they are not very easy to capture when at the hight of their activity: they dodge quickly, and fly across stream frequently. Once, while collecting with a net of red mosquito bar, after trying vainly for half an hour to capture a specimen where specimens were not scarce, I stopped in discouragement with the net under my arm, the bag behind me, and rested. A moment later, looking back over my shoulder, I saw a fine male Hetaerina sitting on the edge of my net. Carefully disengaging the handle from my arm, I managed to sweep him into the bag. Then I turned my attention to the others that were fluttering about the stream, and found I could easily accomplish by strategy what I had failed to do by force. There were few good alighting places about the stream, and I found

that, if I hold the net motionless in front of a flying male he would promptly alight on the edge of it.

But specimens may be captured directly with little trouble at morning or evening, or on cloudy days, when they are less active. Sometimes they assemble in large numbers on the pendant boughs of a willow bush beside a stream at evening, forming with their crimson streaked wings and bodies of black and bronze against the willow background, so charming a picture that the collector will hesitate to disturb it.

The nymphs cling to plants in the rapids; occasionally they live on bulrush stems that fringe the wave-washed shore of a lake. Transformation takes place just above the edge of the water, and, with us, in the month of August. Our common species I have bred several times in widely separated localities. It does not occur at Saranac Inn. It has been several times taken at the head of Cayuga lake at Ithaca. This species (H. americana) may be separated from H. tricolor as follows:

KEY TO SPECIES

a Tibiae with the exterior side yellow.....americana
aa Tibiae entirely black..... tricolor

Hetaerina americana Fabricius

Plate 12

1798 Agrion americana Fabricius, Ent. Syst. Suppl. p.287
1839 Lestes basalis Say, Acad. Nat. Sci. Phila. Jour. 8:35
1839 Calopteryx americana Burmeister, Handb. Ent. 2:826
1854 Hetaerina americana Selys, Monogr. Calopteryginae, p. 131, pl.12, fig.3.
1861 Hetaerina americana Hagen, Synopsis Neur. N. Am. p.60
1863 Hetaerina americana Walsh, Ent. Soc. Phila. Proc. 2:211, 267
1875 Hetaerina americana Hagen, Bost. Soc. Nat. Hist. Proc. 18:23
1893 Hetaerina americana Calvert, Am. Ent. Soc. Trans. 20:228
1895-97 Hetaerina americana Calvert, N. Y. Ent. Soc. Jour. 3:42 and 5:92 (listed from Keeseville, Ithaca and Albany county)
1895 Hetaerina americana Kellicott, Cincinnati Soc. Nat. Hist. Jour. (habits)
1899 Hetaerina americana Kellicott, Odon. Ohio, p.4
1900 Hetaerina americana Williamson, Dragon Flies Ind. p.254
1901 Hetaerina americana Howard, Insect Book, pl.46, fig.11
1901 Hetaerina americana Calvert, Biol. Centr. Am. vol. Neur. p.26-29, pl.2, fig.1–17 (a most complete account of imago)

This is the common and perhaps the only species in New York State. The above account of the habits of the genus has been written with this species in mind. It is as yet recorded from but three localities in the State, but it will doubtless be found in many other places when proper search is made for it. Its nymph has not been described, but in 1880 Dr Hagen drew characters distinctive of the genus from nymphs which he referred to H. californica, H. americana, H. titia and an undetermined species from Brazil.[1] and Calvert[2] and Williamson[3] have used these characters in keys to American nymphs.

Nymph. Length of body 17mm; antennae 4mm additional; gills 7mm additional. Color greenish or brownish, paler on the sutures, on legs and on margins of gill plates, but without distinct color pattern. Occasional specimens show faint indications of darker transverse bands on the tibiae and gill plates.

Fig. 4 Antenna, and end of abdomen showing lateral spines and gill plates, of nymph of Hetaerina americana

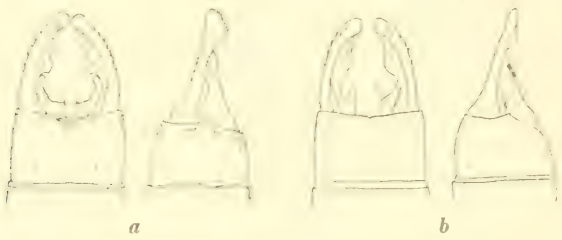
Head flat above, with rounded eyes set well forward, with hind angles obtuse and having a much less distinct superior tooth than that of Calopteryx. Antennae long, inserted into large frontal prominences, somewhat shorter than the head is wide, the first segment longer than the following six, which rapidly and successively decrease in length and thickness. Labium long, the hinge extending posteriorly between the bases of the middle legs; mentum suddenly and greatly dilated in its apical half, its median lobe divided into two lobes by a median cleft, which is rounded basally and extends barely below the level of the bases of the lateral lobes of the labium; the distal end of the cleft is closed by the apposition of the two divisions of the median lobe; beside the cleft on either side is a single small spinule. Each lateral lobe of the labium is straight on its outer margin, with a moderately strong and arcuate movable hook, just before the base of which on the superior margin are three small spinules. The exposed portion of the inner margin is strongly convex, and finely serrulate, and terminates after a sigmoid curve, in a short, stout, strongly arcuate end hook;

[1] Ent. Soc. Belgique, Compte Rendu, 23:65.
[2] Am. Ent. Soc. Trans. 20:225.
[3] Dragon Flies of Indiana, p.247.

above the end hook on the distal margin are two other strong hooks, the one next the end hook being twice the size of the other above it.

Prothorax with a pair of elevated, round tipped prominences each side of the dorsum. Legs thin, smooth, long. Wing cases reaching as far as the base of segment 5 of the abdomen.

Abdomen smooth, cylindric, with lateral margins becoming sharp posteriorly and generally ending on segments 7-9 in a sharp, flat, lateral spine. Gills variable in size, and easily broken off; the median one flat, the two lateral ones triquetral, all with thin margins, and apexes rather obtuse.



a *b*

Fig. 5 Hetaerina: male abdominal appendages; *a*, H. americana; *b*, H. tricolor

Hetaerina tricolor Burmeister

1839 Calopteryx tricolor Burmeister, Handb. Ent. 2:827
1854 Hetaerina tricolor Selys, Monogr. Calopteryginae, p.136, pl.12, fig.5
1861 Hetaerina tricolor Hagen, Synopsis Neur. N. Am. p.61
1875 Hetaerina tricolor Hagen, Bost. Soc. Nat. Hist. Proc. 18:24
1893 Hetaerina tricolor Calvert, Am. Ent. Soc. Trans. 20:229
1899 Hetaerina tricolor Kellicott, Odon. Ohio, p.13
1900 Hetaerina tricolor Williamson, Dragon Flies Ind. p.255
1901 Hetaerina tricolor Howard, Insect Book, pl.46, fig.19

This handsome dark colored species is not as yet known from New York. Its nymph is unknown.

Subfamily LESTINAE

A single genus is included within our fauna.

LESTES

This large and cosmopolitan genus is represented among us by a number of interesting and beautiful species. They are abundant in marshes, in shallow pools filled with standing aquatics and about the reedy borders of streams and ponds. They are rarely seen either over open water, or at any consider-

able distance from water. They habitually rest among the stems of tall growing rushes and sedges, or flit from stem to stem in short, shadowy flights. Notwithstanding the brilliant metallic colors of some species, they are by no means conspicuous in their native haunts; their greens and browns, and their slender bodies and transparent wings are lost against a background of reeds and sedges.

They feed extensively, perhaps chiefly, on such small gnats, mosquitos etc. as emerge from the water of their own native shallows, or such as rest in hiding during the daytime among the rushes. I have often seen a Lestes dart out and capture a gnat in flight, and then settle on a stem to devour it at leisure.

The females (of two species at least, L. uncata and L. unguiculata) deposit their eggs in punctures made in the stems and leaves of plants above the water. For this purpose they utilize the leaves of bur reed or of any of the coarser sedges or grasses, or the flowering stems of the blue flag. The stems and leaves selected for oviposition, usually well exposed clumps here and there about the pools, are often filled full of eggs for a distance of a foot above the surface of the water.

I have studied Lestes chiefly in the two species named above, which are common about my home in Lake Forest, occurring in shallow pools of the springtime, that dry out thoroughly every summer, and are usually refilled by the rains of late autumn. I have already published[1] some observations made there, on the destruction of the fruit of the blue flag by the puncturing of the fruit stalks by Lestes ovipositing. I will give here some additional observations of facts more immediately concerning the insects themselves.

In these pools, which are always dried out by midsummer, the eggs, deposited well above the water, develop normally from the first, and in the course of two or three weeks attain a condition which is apparently almost that in which they will hatch. Then they estivate through the remainder of the summer and early autumn. Development stops apparently entirely.

[1]American Naturalist, 34:374-75.

and remains stopped till the pools are refilled in late autumn, and the stems and leaves, now dead, fall into the water. I have gathered the eggs in the middle of July and again in the middle of October and found them at apparently the same stage of development. Eggs placed at the latter date in a bowl of water in my laboratory hatched within a week. I did not try hatching any of them earlier.

Exposed as they are above the water, these eggs are subject to parasites, which destroy often a large proportion of them. From a handful of bur reed leaves well studded with Lestes eggs

Fig. 6 The egg of Lestes unguiculatus

I once bred large numbers of the following parasites, the two last named being hyperparasites on the third named in the list.

Brachista pallida Ashm.
Centrobia odonatae Ashm.
Polynema needhami Ashm.
Tetrastichus polynemae Ashm.
Hyperteles polynemae Ashm.

The nymphs live among submerged plant stems. Their extremely slender legs, long swaying bodies, and leaflike gill plates, together with a sober color pattern of greens and browns, render them very inconspicuous when in their native haunts. In aquariums they are rather shy, and do not feed under observation so readily as do many other genera. I have observed them eating some of the larger entomostraca and smaller dipterous larvae (Corethra and Chironomus).

Since the nine species occurring in or regional in New York State have all been described several times in recent and available papers, and since the females are well nigh indistinguishable, and determinations must at present be based on the males and chiefly on the form of the terminal abdominal appendages of the males, I have not thought it worth while to give descrip-

tions of imagos. I present a key based chiefly on the form of the male appendages, which will be sufficient, I trust, for the determination of species. Of these nine species I have reared five. I regret to acknowledge, after prolonged study of them, that I find them well nigh indistinguishable specifically. Aside from slight and inconstant differences in size and a few very minor structural characters, they are all alike. I will give therefore a general description of them and supplement it with a tabular statement of such differences as I have thus far been able to discover between them.

Nymph. The nymph of Lestes is exceedingly long and slender, with wide head, deep thorax and slender, cylindric ab-

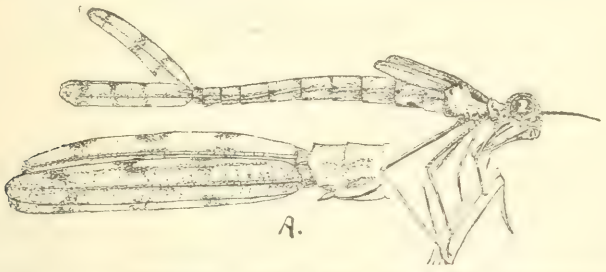


Fig. 7 Nymph of Lestes rectangularis; A, gills, more enlarged

domen, bearing linear-oblong gill plates. Head twice as wide as long, only moderately prominent at the front; eyes prominent, rounded, directed somewhat anteriorly; hind angles low, well rounded, with a shallow wide notch between them on the hind margin; antennae longer than the head, with the segments increasing in length to the third, and decreasing thereafter to the tip, seven-jointed. Labium [pl.14, fig.*c*] long and exceedingly slender, the hinge reaching as far posteriorly as the hind legs, but dependent, and not closely applied to the ventral surface of the body; mentum linear to the suddenly dilated, and spoon-shaped tip; median lobe moderately prominent, with a closed median cleft which extends as far proximally as the level of the bases of the lateral lobes; mental setae well developed; lateral lobe very complicated [*see* pl.14, fig.*d*], bent almost at a right angle just beyond its base, having a very large movable hook, beyond the base of which the distal portion is cleft into two parts, the inner one of which bears the end hook and the usual inner series of teeth, these being very numerous, regular and deeply cut; the outer part is widened distally, with its distal angles pro-

duced in long hooks, of which the outer is twice the larger and each of these hooks is separated by a shallow notch from a row of 5–9 minute teeth on the distal margin. There are three lateral setae, *two on the movable hook*, and one just before its base.

Prothorax conic, tapering forward to its attachment to the head. Legs very long and slender, generally faintly annulate with darker color. Wing cases narrow, elevated, their tips hardly reaching the base of the fourth abdominal segment.

Abdomen cylindric, with lateral margins becoming sharp posteriorly, ending on the fourth or fifth to ninth segments in minute but sharp lateral spines; segments 2–9 of about equal length, 1 and 10 shorter and about equal each to the other. Gills long, with parallel sides and abruptly rounded ends, distinctly segmented for part of their length, and generally transversely banded with brown.

KEY TO SPECIES

Imagos[1]

a Inferior appendages of the male not longer than half the superiors
  b A large metallic green species: length of hind wing 25-29 mm..... eurina
  bb A smaller, blackish brown species: length of hind wing 18-22mm..... congener
aa Inferior appendages of the male abdomen longer than half but not longer than the superiors
  c Inferior appendages, viewed from above, exhibiting a sigmoid curvature..... unguiculata
  cc Inferior appendages viewed from above, straight or nearly so
    d Metallic green species (when mature)
      e Inferior appendages of the male viewed from above strongly dilated toward the apex .... uncata
      ee Inferior appendages of the male very slender and straight in their apical half..... vigilax
    dd Blackish brown species
      f Apex of inferior appendages of male bent downward at the tip.....rectangularis
      ff Apex of inferior appendages not distinctly declined
        g Inferior appendages of the male viewed from above slightly widened at the tip; of the two teeth on the inner edge of superior appendage, the basal one is much the larger..... forcipata

[1] After Calvert. Am. Ent. Soc. Trans. 1893. 20:229-32.

gg Inferior appendage of the male not widened at tip; the proximal tooth on inner margin of each superior appendage little larger than the distal one..... disjuncta

aaa Inferior appendages of the male longer than the superior, and bent inward and tufted with hairs at the tip..... inequalis

Here are the differences observed to exist between the nymphs of the species I have reared.

Nymphs

a On each side of the mentum five to six raptorial setae [pl.14, fig.*c*].....forcipata and rectangularis

aa On each side of the mentum normally seven raptorial setae

b Length when full grown about 31mm.....unguiculata and uncata

bb Total length when grown about 37mm.....eurina

aaa Unknown.....congener, disjuncta, vigilax and inequalis

Lestes eurina Say

1839 Lestes eurina Say, Acad. Nat. Sci. Phila. Jour. 8:36
1861 Lestes eurina Hagen, Synopsis Neur. N. Am. p.70
1891 Lestes eurina Scudder, Psyche, 6:66
1893 Lestes eurina Calvert. Am. Ent. Soc. Trans. 20:229, pl.3, fig.14
1895 Lestes eurina Calvert. N. Y. Ent. Soc. Jour. 3:42 (listed from Dobbs Ferry)
1900 Lestes eurina Williamson, Dragon Flies Ind. p.256
1901 Lestes eurina Davis, Nat. Sci. Ass'n Staten Island. Proc. v.8, no.3 (not seen by me)
1901 Lestes eurina Needham, N. Y. State Mus. Bul. 47, p.518 (mention of its habitat and associates)

This large and handsome species was common at Saranac Inn about the edges of all sphagnum-bordered ponds, where it was associated with L. uncata and L. unguiculata, and with other genera. I bred it there on June 20, 1900, and again at Lake Forest Ill., where it is rather uncommon, on June 12, 1901.

Lestes congener Hagen

1861 Lestes congener Hagen, Synopsis Neur. N. Am. p.67
1893 Lestes congener Calvert. Am. Ent. Soc. Trans. 20:229, pl.3, fig.15
1895 Lestes congener Calvert, N. Y. Ent. Soc. Jour. 3:42 (listed from Lake St Regis)
1895 Lestes congener Kellicott, Cincinnati Soc. Nat. Hist. Jour. 17:200, 202
1899 Lestes congener Kellicott, Odon. Ohio, p.15, fig.17
1900 Lestes congener Williamson, Dragon Flies Ind. p.256

For this species I can only add a new locality to the records of its occurrence; I have taken it at Ithaca. Its nymph is unknown.

Lestes unguiculata Hagen

1861 Lestes unguiculata Hagen, Synopsis Neur. N. Am. p.70
1893 Lestes unguiculata Calvert, Am. Ent. Soc. Trans. 20:230, pl.3, fig.16
1895 Lestes unguiculata Calvert, N. Y. Ent. Soc. Jour. 3:42 (listed from Westchester county)
1899 Lestes unguiculata Kellicott, Odon. Ohio, p.16, fig.23
1900 Lestes unguiculata Williamson, Dragon Flies Ind. p.257, pl.7, fig.1

This widely distributed species I have collected at two unrecorded localities in New York State, Saranac Inn and Ithaca. I have bred it several times in June at my home in Lake Forest Ill., where it is abundant. The metallic green of the mature males is very brilliant.

Lestes uncata Kirby

1861 Lestes forcipata Hagen, Synopsis Neur. N. Am. p.71
1900 Lestes uncata Kirby, Cat. Neur. Odon. p.160 (renamed)
1893 Lestes uncata Calvert, Am. Ent. Soc. Trans. 20:230, pl.3, fig.18
1895 Lestes uncata Calvert, N. Y. Ent. Soc. Jour. 3:42 (listed from Keeseville and Ithaca). 5:92 (listed from Buffalo)
1899 Lestes uncata Kellicott, Odon. Ohio, p.17, fig.20
1900 Lestes uncata Williamson, Dragon Flies Ind. p.257, pl.7, fig.2

This species flies through most of the summer at Saranac Inn, and is a common midsummer species at Ithaca. It is a characteristic denizen of shallow woodland pools. In such a pool near Glen Ellyn Ill., I once saw dozens of nymphs in transformation at a time on May 30, and I have bred the species in many places. Notes on the oviposition of this species and the last have already been given under the account of the genus.

Lestes disjuncta Selys

1862 Lestes disjuncta Selys, Acad. Belg. Bul. (2) 13:302
1893 Lestes disjuncta Calvert, Am. Ent. Soc. Trans. 20:231, pl.3, fig.19
1895 Lestes disjuncta Calvert, N. Y. Ent. Soc. Jour. 3:42 (listed from Lake St Regis, Keeseville and Ithaca)
1899 Lestes disjuncta Kellicott, Odon. Ohio, p.18
1900 Lestes disjuncta Williamson, Dragon Flies Ind. p.258.

I have not seen this species at large. Its nymph is unknown.

Lestes forcipata Rambur

1842 Lestes forcipata Rambur, Ins. Neur. p.246
1861 Lestes hamata Hagen, Synopsis Neur. N. Am. p.70
1893 Lestes forcipata Calvert, Am. Ent. Soc. Trans. 20:231, pl.3, fig.20
1895-97 Lestes forcipata Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from N. Y. city, Ithaca and Schoharie)
1899 Lestes forcipata Kellicott, Odon. Ohio, p.19, fig.19
1900 Lestes forcipata Williamson, Dragon Flies Ind. p.258, pl.7, fig.3

This widespread species I bred in June 1896 at Galesburg Ill. and in June 1898 at Ithaca N. Y. It was not observed at Saranac Inn. I have always found the species about the borders of ponds of permanent nature.

Lestes rectangularis Say

1839 Lestes rectangularis Say, Acad. Nat. Sci. Phila. Jour. 8:34
1893 Lestes rectangularis Calvert, Am. Ent. Soc. Trans. 20:231, pl.3, fig.21
1895-97 Lestes rectangularis Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from Dobbs Ferry, N. Y. city, Ithaca, Saratoga lake, New Baltimore, Schoharie and Buffalo)
1898 Lestes rectangularis Kellicott, Odon. Ohio, p.20, fig.18
1898 Lestes rectangularis Needham, Outdoor Studies, p.62, 68, fig.63, 73 (account of habits and figures of imago and nymph)
1900 Lestes rectangularis Williamson, Dragon Flies Ind. p.259, pl.7, fig.5

This exceedingly attenuated species is quite similar in appearance and habits to the preceding, and its nymph, which I have several times bred, appears to me quite indistinguishable from that species. I did not find it at Saranac Inn.

Lestes vigilax Selys

1862 Lestes vigilax Selys, Acad. Belg. Bul. (2) 13:306
1893 Lestes vigilax Calvert, Am. Ent. Soc. Trans. 20:232, pl.3, fig.17
1898 Lestes vigilax Kellicott, Odon. Ohio, p.20, fig.18
1900 Lestes vigilax Williamson, Dragon Flies Ind. p.259, pl.7, fig.4

This species has not been recorded from the State hitherto. It is found at Cold Spring Harbor, L. I. Its nymph is unknown.

Lestes inequalis Walsh

1862 Lestes inequalis Walsh, Acad. Nat. Sci. Phila. Proc. p.385
1893 Lestes inequalis Calvert, Am. Ent. Soc. Trans. 20:232, pl.3, fig.24

1898 Lestes inequalis Davis, N. Y. Ent. Soc. Jour. 6:196 (listed from Staten Island)
1898 Lestes inequalis Kellicott, Odon. Ohio, p.21, fig.22
1900 Lestes inequalis Williamson, Dragon Flies Ind. p.260, pl.7, fig.6

This species is as yet known only from Staten Island, but is very likely to be found elsewhere. Its nymph is unknown.

Subfamily AGRIONINAE

KEY TO GENERA

Imagos

a Spines on the tibiae very long, twice as long as the intervals between them..... Argia
aa Spines of the tibiae hardly longer than the intervals between them
b No pale postocular spots on the top of the head; sexes similarly colored
c Colors of dorsum blue and black; yellow beneath the thorax..... Chromagrion
cc Colors of dorsum red and black; stout species Amphiagrion
ccc Dorsum bronzy green; slender species..... Nehalennia
bb With round or ovoid postocular spots on the head
d Sexes with a general similarity in color, the female often of a lighter shade; no upturned, bifid process arising from the apex of the 10th abdominal segment (except in the species last in our list); the superior abdominal appendages of the male not strongly directed downward and inward..... Enallagma
dd Sexes strikingly unlike in color; a bifid process arising from the apical margin of the 10th abdominal segment in the male and the superior abdominal appendages strongly directed downward and inward
e Males chiefly green and black, with normal rhomboidal pterostigma; females with the orange of the abdomen covering something less than the three basal segments (becoming wholly densely pruinose with age)..... Ischnura
ee Males yellow or orange, with ovoid stigma which does not reach the costal vein; females with the four basal segments of the abdomen yellow or orange. Anomalagrion

Nymphs

a Labium with no raptorial setae on the mentum within; gills broad, thick, dark colored, oval or oblong in shape and obtuse at apex ..... Argia

aa Labium with mental setae; gills thinner, more pointed and narrower [pl.15]

b Hind angles of the head strongly angulate

c Gills widest beyond the middle; body slender; head half as long as wide..... Chromagrion

cc Gills widest across the middle; body stouter; head nearly as long as wide..... Amphiagrion

bb Hind angles of the head rounded

d Labium with one mental seta (and a rudimentary second one) each side; antennae six-jointed; lateral lobe of the labium with the distal end above the end hook hardly denticulated ..... Nehallennia

dd Labium with three to five mental setae each side (one may be smaller than the others), and end of lateral lobe denticulated distinctly; antennae seven-jointed (with the possible exception of E. antennatum)

e Gills more than half as long as the abdomen, lanceolate; third segment of antennae less than a third longer than the second

f Labium with four to six lateral setae, generally with five, and with three (rarely four) mental setae each side; gills often with a definite color pattern..... Enallagma

ff Labium with five or six lateral setae, and with four mental setae each side; gills generally with no distinct pattern..... Ischnura

ee Gills less than half as long as the abdomen, narrower and with a long tapering point; third segment of antenna more than a third longer than the second.....Anomalagrion

ARGIA

This is another large genus whose species are nearly all American, and whose habitat is chiefly tropical or subtropical. In New York State are recorded five species, and a sixth is regional and is included in this list. Of these six, four have been bred, and their nymphs are here described for the first time.

In habits our species are somewhat diverse. In general, it may be said that they frequent the borders of the larger bodies and streams of water, and both in the water and out of it after transformation they cling to the surfaces of stones, piers, timbers, bare banks, etc., rather than to vegetation. Imagos may be found squatting on a bare bank much more frequently than clinging to its neighboring plants, but they will travel out among the plants when foraging, following then by preference a bare path or roadway.

The eggs are deposited mostly on the alga-covered surfaces to which the nymphs will afterward cling. In ovipositing the male usually retains his hold on the prothorax of the female, and

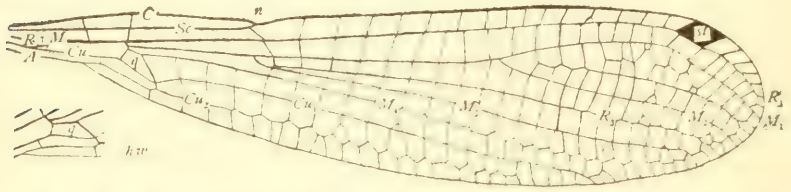


Fig. 8 Fore wing of Argia fumipennis, with quadrangle (*q*) of hind wing

when, as happens frequently with the first species of our list at least, she descends beneath the surface of the water to place her eggs at a lower level, he is carried along.

The nymphs of Argia are usually recognizable at a glance, by reason of their thick set bodies and short, broad and dark colored gills. If these be not sufficient, the entire absence of raptorial setae from the mentum of the labium will certainly distinguish them from all our other genera of Agrioninae. The nymphs are so much alike that a generic description of them may be given here, saving much repetition.

Nymph. Short and thick and usually dark colored, with short legs and short-oblong gill plates [pl.15, *a*]. The head is somewhat wider than long, flat above, with very prominent eyes, behind which the sides are parallel as far as the obtusely rounded hind angles, between which is a deep round posterior emargination. The antennae are six to seven jointed, with the third joint longest. The labium [pl.14, *e* and *f*] is short, with hinge barely reaching posteriorly to the base of the

middle legs; the mentum is less than a third longer than wide; median lobe spinulose on its prominent free border; no mental setae; lateral setae one to four; lateral lobe short, half as wide as long, with short, stout, movable hook and small end hook separated by a more or less distinct notch from the inner margin, and with one or more smaller teeth on the distal end above the end hook.

Prothorax pointed anteriorly and fitting the rear emargination of the head. Mesothorax and metathorax much thicker,

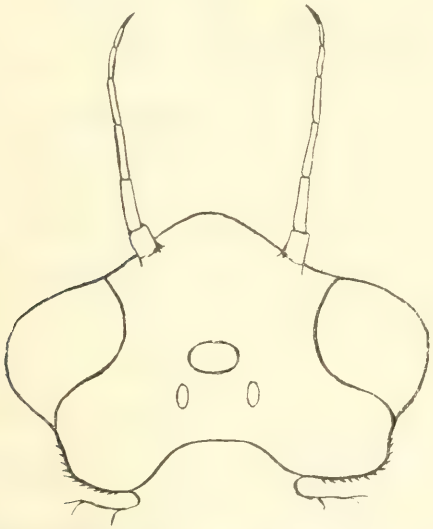


Fig. 9 Outline of head of nymph of Argia apicalis

with the wings borne at a considerable elevation. Legs short, usually banded transversely, and bearing spines as well as hairs.

Abdomen stout, somewhat tapering, and with its segments decreasing in length to the ninth, the tenth again a little longer. Gills oblong about half as long as wide, obtuse at apex and generally with paler apical markings. Among alcoholic specimens frequently, and among fresh specimens occasionally, the gills are absent, being easily broken off. If their loss occur early in nymphal life, they are regenerated, and it is no uncommon thing to find a specimen with one, two or three of the gill plates of smaller size than the normal. The loss of the gills seems not to affect seriously the respiration of the nymphs.

The following keys will serve for the separation of our species.

KEY TO THE SPECIES

Imagos

a Dorsum of the apical segments of the abdomen of the male blackish; pterostigma surmounting more than one cell, i. e. longer than the cell behind it..... putrida

aa Dorsum of apical segments of abdomen of male with blue restricted to W-shaped basal marks on segments 8 and 9; stigma generally surmounting somewhat more than a single cell.. translata

aaa Abdominal segments 9 and 10 blue, 1–7 black..... tibialis

aaaa Abdominal segments 8, 9 and 10 blue, 1–7 ringed with blue or violet

b Colors light blue and black: humeral stripe of black very narrow, a mere line, suddenly widened at its lower end..... apicalis

bb Colors deep blue and black, humeral stripe of black very broad, broader than the preceding stripe of blue.....bipunctulata

bbb Colors violet and black; humeral stripe bifid superiorly, the posterior fork not reaching the alar carina..... violacea

Nymphs

a With a single very minute lateral raptorial seta..... putrida

aa With three or four well developed lateral setae

b With three well developed lateral setae (occasionally, a rudimentary fourth in apicalis)

c Median lobe of labium one third as long as it is wide apicalis

cc Median lobe of labium one fourth as long as it is wide violacea

bb With four well developed lateral setae..... tibialis

aaa Unknown.....bipunctulata and translata

Argia putrida Hagen

1861 Agrion putridum Hagen, Synopsis Neur. N. Am. p.96

1865 Argia putrida Selys, Acad. Belg. Bul. (2) 20:385

1893 Argia putrida Calvert, Am. Ent. Soc. Trans. 20:232

1896 Argia putrida Kellicott, Cincinnati Soc. Nat. Hist. Jour. 18:110 (observations on manner of oviposition)

1895-97 Argia putrida Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from Niagara, Ithaca, Schoharie and Buffalo)

1899 Argia putrida Kellicott, Odon. Ohio, p.23 (description and habits)

1900 Argia putrida Williamson, Dragon Flies Ind. p.261 (description and habits)

1902 Argia putrida Williamson, Ent. News, 13:67 (oviposition; feeding, fig. of eggs on pinnule of Osmunda.

This is our largest species. It was not common at Saranac Inn, though a few could be found at any time about the timbers by the shores of the larger ponds. I bred it there. I had previously bred it at Ithaca, where it is very common, and during the summer of 1901 I bred from Fall creek many additional examples. The species is a common and characteristic one about the shores of the great lakes. It belongs on wave-beaten shores and in the larger and more rapid streams. In Fall creek its nymphs are found under stones in even the swiftest water, clinging, as stone flies cling, to the rocks. It is the only dragon fly to be found inhabiting such situations.

Kellicott made some interesting observations on the species at Lakeside on Lake Erie. The species was ovipositing in pairs on the dock timbers. The females would sometimes descend the timbers into the water, carrying the males with them. The females would remain submerged a long time (once almost an hour) while ovipositing, but the males would disengage themselves and come up out of the water after 5 to 20 minutes. The descent is made by the backing downward of the female as she reaches ever for new territory in which to distribute her eggs.

Nymph. Length 17mm, gills 6mm additional, abdomen 10mm; width of head 4mm. Antennae seven jointed, the second joint one third longer than the first. The single raptorial seta of the lateral lobe of the labium is very minute, difficult to see at all. The median lobe of the labium is very prominent, about half as long as it is wide. In the center of the mentum is an elongate V-shaped chitinization, the V opening forward. The abdomen is relatively long, the wing cases reaching scarcely to the base of the fourth segment. The gills are more than twice as long as wide, with parallel margins and obtuse apexes, blackish, with the apical fifth more or less covered with white.

The head is more depressed, and the legs are more sprawling than in other species, due perhaps to the habitat. The stone flies and May flies living in rapids are modified in form along the same lines. At transformation the nymphs depart farther from the water than in the other species, often going several yards up the banks.

The seasonal range for imagos of this species is from May till October.

Argia apicalis Say

Plate 17, fig. 1

1839 Agrion apicalis Say, Acad. Nat. Sci. Phila. Jour. 8:419
1861 Agrion apicale Hagen, Synopsis Neur. N. Am. p.91
1893 Argia apicalis Calvert, Am. Ent. Soc. Trans. 20:233
1898 Agrion apicalis Davis, N. Y. Ent. Soc. Jour. 6:196 (listed from Staten Island)
1899 Argia apicalis Kellicott, Odon. Ohio, p.26 (description)
1900 Argia apicalis Williamson, Dragon Flies Ind. p.264

This species I did not find either at Saranac Inn or at Ithaca, but I bred it in 1895 at Galesburg Ill., and in 1896 at Havana Ill. At Galesburg it was exceedingly abundant on the clayey banks of a rather deep woodland pond; at Havana it is exceedingly abundant at the mouth of the Spoon river, and on the west bank of the Illinois river below that point. On the sandy east bank of the Illinois river I did not observe it at all.

Imagos when fully mature are of a very bright, beautiful blue color, unobscured by pruinosity, as in the last species. But they are long in attaining their full coloration, and teneral specimens are of a pale flesh tint. I observed the imagos, both teneral and mature, at Galesburg feeding voraciously on adult Chironomids. Transformation takes place on some bank or projecting timber within a few inches of the edge of the water.

Nymph. Length 12.5mm, gills 5mm additional, abdomen 8mm; width of head 3.1mm. Antennae six-jointed. Lateral setae three, occasionally four, but then the fourth is much smaller than the others. Median lobe of labium with a median Y-shaped chitinization, the arms of the Y projecting forward. Gills half as wide as long, with margins parallel for a distance, usually showing a paler transverse streak at three fourths their length. Wing tips reaching well across the sixth abdominal segment.

Nymphs of this species kept in an aquarium at Galesburg intermittently swayed the abdomen from side to side, apparently as an aid to respiration; yet other nymphs in the same aquarium, having lost their gills, did not seem to suffer in consequence, though kept for weeks, and finally transformed into perfect specimens.

Argia violacea Hagen

Plate 13, fig. 4, 5

1861 Agrion violaceum Hagen, Synopsis Neur. N. Am. p.90
1893 Argia violacea Calvert, Am. Ent. Soc. Trans. 23:233

1893-95 Argia violacea Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from Keeseville, Dobbs Ferry, Ithaca and Buffalo)
1899 Argia violacea Kellicott, Odon. Ohio, p.25 (description)
1900 Argia violacea Williamson, Dragon Flies Ind. p.262 (description)
1901 Argia violacea Needham, N. Y. State Mus. Bul. 47, p.402, 405, 407 (occurrence at Saranac Inn)

This species is one of the most generally distributed in the northeastern United States. In habitat it approaches species of Lestes and Enallagma, dwelling by ditches and slow streams, and in the bays of larger bodies of standing water. The beautiful violaceous color of the adult males in life is fairly distinctive of the species, and has suggested the specific name.

This species like the preceding oviposits commonly in mats of algae lying at the edge of the water, or covering floating vegetation. On such mats I have frequently seen many females at work side by side, each with a male clasping her prothorax with his forceps, his body sticking up straight in air, his legs and wings placidly folded. This curious position, standing, as it were, on the tip of the abdomen, is assumed, I think, not so much on account of the male trying to avoid the water, as Kellicott has suggested,[1] as on account of the greater ease of maintaining this position. The inferior appendages of the male are so much longer than the superiors that were the male to remain with his feet on the ground, when the female depresses her abdomen in ovipositing, the flexion of his body would be extreme, and perhaps uncomfortable. At any rate, he takes the elevated position very philosophically, folds his legs and waits till his spouse gets ready to let him down; and, when she wants to move from place to place, he uses his wings to help her.

Nymph. Length 10mm, gills 4mm additional, abdomen 6mm; width of head 3mm. Antennae six jointed. Median lobe of labium less prominent than in the other species. Lateral setae three. Wings reaching well on the sixth abdominal segment. Gills ovate broadly, obtuse, with the margins hardly parallel anywhere, an obscure transverse paler streak at three fourths their length.

[1] Cincinnati Soc. Nat. Hist. Jour. 17:203

The nymphs found in Little Clear creek, where most abundant, were often deeply incrusted with a reddish brown deposit, and in July many of them were further decorated with a number of living red hydras attached to their backs, as shown on plate 13, figure 5.

Argia tibialis Rambur

Plate 15, *a*

1842 Platycnemis tibialis Rambur, Ins. Neur. p.241
1861 Trichonemis tibialis Hagen, Synopsis Neur. N. Am. p.72
1865 Argia tibialis Selys, Acad. Belg. Bul. (2) 20:413
1893 Argia tibialis Calvert, Am. Ent. Soc. Trans. 20:233

This species is not yet known from New York State, but it has been reported from Pennsylvania, and may be found here also. Its range extends westward and southward to Illinois and Texas. I have a number of specimens that were bred by Mr F. G. Schaupp at Shovel Mount Tex., between Aug. 13 and Aug. 18, 1898. From the cast skins, and from a few additional specimens apparently belonging to the same species, I have drawn the following brief descriptive characters.

Nymph. Length 12mm, gills 4.5mm additional, abdomen 8mm; width of head 3.2mm. Color greenish or brownish, marked with darker in a double row of elongate spots on the dorsum of the abdomen, and in two faint transverse bands on each femur. Structurally it differs from the preceding species only in the following points: there are four lateral setae on the labium, in a regular series; the end hook of the lateral lobe is not separated from the inner margin by an incision; the tooth on the end above the end hook is smooth and not denticulated superiorly; the gills are ovoid oblong, widest just beyond the middle and rather abruptly rounded on the tip, and they show hardly any area of lighter color apically. Antennae six jointed; other characters as in the preceding.

Argia bipunctulata Hagen

1861 Agrion bipunctulatum Hagen, Synopsis Neur. N. Am. p.90
1865 Argia bipunctulata Selys, Acad. Belg. Bul. (2) 20:415
1893 Argia bipunctulata Calvert, Am. Ent. Soc. Trans. 20:234

This species is recorded from New Jersey, but is not yet known from New York State. Its nymph is still unknown.

Argia translata Hagen

1865 Argia translate Hagen, Acad. Belg. Bul. (2) 20:410
1901 Argia translata Calvert, Ent. News. 12:326 (recorded from New York State)

This species, discovered in our State by Dr Calvert at White Lake, Sullivan co., Aug. 2, 1898, was previously recorded only from Venezuela. Its nymph is unknown.

CHROMAGRION gen nov.

Since the repartition of the old genus Agrion in 1876, the North American Agrion conditum of Hagen has generally been written ?Erythromma conditum, its affinity with Erythromma being doubtful on account of notable differences in venation, in form of abdominal appendages and in type of coloration between this species and the typical species of the genus. The discovery of the nymph now gives opportunity for comparison of nymphal characters; the differences here are equally noteworthy. A tabular comparison of the principal characters of the nymph of our species with the nymphs of typical species of Erythromma and Pyrrhosoma (the only genera with affinities close enough to make such comparison necessary) will make clear the reasons (added to the well known differences of imagos) for proposing the establishment of a new genus.

CHARACTER OF NYMPH	CHROMAGRION (A. conditum type)	ERYTHROMMA	PYRRHOSOMA
Hind angles of head	strongly angulate	strongly angulate	rounded
Gills	long and narrow, widening almost to the tip, then suddenly contracted, then pointed	broad, oblong with parallel sides, obtusely rounded on tip	oblanceolate, contracted near tip and then pointed
Mental setae of labium	3 and a rudimentary 4th	3–4, usually 4	1, and a rudimentary 2d
Lateral setae	5	6–7	7–8
End of lateral lobe of labium, above end hook	squarely truncate, angled superiorly scarcely denticulate	less square, with 3 strong teeth	obliquely truncate, rounded superiorly and not denticulate

In addition to the differences in coloration and appendages clearly stated by de Selys as distinguishing this species from the typical erythromma, there are differences of venation which may be indicated by tabular comparison:

CHARACTER	ERYTHROMMA	CHROMAGRION
Anterior side of the quadrangle	shorter (f. w.) or equal (h. w.) to the inner side	2 (f.w.) to 2½ (h.w.) times the length of the inner (proximal) side
Anal vein separating from the hind margin	much before the vertical cubitoanal cross vein	just before or opposite the obliquely placed cubitoanal cross vein
Vein M_4 beginning to be angulate (f. wing)	opposite the origin of vein M_2	4-5 cells beyond the level of the origin of vein M_2, and near the level of the stigma
Areoles behind vein Cu_2	wider than long	longer (in the axis of the wing) than wide

Chromagrion conditum Hagen

Plate 13, fig. 1-3

1876 ?Erythromma conditum Hagen, Acad. Belg. Bul. (2) 41:1305

1893 ?Erythromma conditum Calvert, Am. Ent. Soc. Trans. 20:234

1895-97 Erythromma conditum Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from Ithaca and Hamburg)

1899 Erythromma conditum Kellicott, Odon. Ohio, p.28

1900 ?Erythromma conditum Williamson, Dragon Flies Ind. p.265

My first morning at Saranac Inn (June 14, 1900) I went out before breakfast along the southwest side of the outlet of Little Clear pond, and found in a little trashy bay near the pond Tetragoneuria spinigera, Ladona julia, Leucorhinia glacialis and this species all transforming together. Later, I found nymphs of Cordulia shurtleffi in the same shallows. Chromagrion transformed perhaps a little farther out from shore than any of the others, clambering up the projecting twigs of small trees that had been felled in the edge of the pond outlet, and transforming a few inches above the surface of the water.

Previously I had found the species, likewise in transformation, at MacLean N. Y., when on May 30, 1897, in company with Mr A. D. MacGillivray, I went on a collecting trip from Ithaca thither. There it inhabited a spring-fed pool near the banks of Fall creek. Specimens in all stages were picked from the culms of the grasses and sedges standing in the pool.

The imagos appear to keep rather close to shelter and to their native shallows, spending but little time on the wing. Transformation takes place for the most part in the morning or early forenoon, and the place selected is at most but a few inches above the water. The species is of wide distribution, but is everywhere quite local. Imagos will be readily recognized from the unique combination of blue and yellow on the thorax, shown on plate 13, figure 2.

Nymph. Measures in length 12mm, gills 6mm additional. Color greenish brown, paler beneath, marked with darker brown on frons, hind angles of the head sides of thorax and middle of abdominal segments; legs with two darker transverse bands on the femora and a less distinct, basal one on all tibiae; gills greenish brown, with a series of darker points along the spinose margins and with paler apexes.

Body slender; head wide, with large and strongly angulate hind angles and a deep posterior notch between them; antennae seven jointed. Labium rather short, the hinge reaching posteriorly between, but not beyond, the bases of the fore legs. Median lobe moderate; mental setae three each side; lateral setae five. Thorax narrower than the head. Legs slender, very scantily hairy, but with a double inferior row of spines. Wings reaching posteriorly well on the base of the fifth abdominal segment. Abdomen with sides parallel, or very little tapering toward the tip. Gills narrowly oblanceolate, widest at four fifths their length.

AMPHIAGRION

A single species falls within the limits of our fauna.

Amphiagrion saucium Burmeister

Plate 18, fig. 1-3; plate 15, *c*

1839 Agrion saucium et A. discolor Burmeister, Handb. Ent. 2:819.
1876 Amphiagrion saucium Selys, Acad. Belg. Bul. (2) 41:285
1890 Amphiagrion discolor Kirby, Cat. Neur. Odon. p.143
1893 Amphiagrion saucium Calvert, Am. Ent. Soc. Trans. 20:235

1895-97 Amphiagrion saucium Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from Westchester county, Ithaca, Karner and Buffalo)

1898 Amphiagrion saucium Davis, N. Y. Ent. Soc. Jour. 6:196 (listed from Staten Island)

1899 Amphiagrion saucium Kellicott, Odon. Ohio, p.31

1900 Amphiagrion saucium Williamson, Dragon Flies Ind. p.267

This is a meadow-rivulet-loving species. I have found it in a number of localities, but only in very small, reed choked, spring-fed brooks. The imagos, which will at once be recognized by their deep red color, are found only in the vicinity of their native streamlet, where they flit about chiefly among the stems in or overhanging the water.

In 1896 I located the species in a small meadow brook near the head of Lake George at Galesburg Ill., but too late for rearing it that season. The following year, having removed to New York, I requested Dr W. E. Castle, then living in Galesburg, to collect and rear the nymphs. This he did, securing the first transformation of a specimen June 2, 1897. To Dr Castle, therefore, belongs the credit for material for this life history. Further specimens of the nymphs from the same brook were sent me afterward by Mr G. B. Smith of Knoxville Ill., and I have since received others from various points in the West. The nymph is at once recognized among related forms by its thickset body and the remarkably prominent hind angles of the head.

Nymph [pl.18, fig.3]. Measures in length 11mm, gills 4mm additional. Color brownish, paler on antennae and on sutures; eyes and a divided median line on the thorax black; abdomen with lateral margins pale, a black point above and another below this line toward the apex of each segment; gills pale, with a series of black dashes along the axis; tibial spines and apexes of all leg segments and claws brown.

Body and legs short and thick. Head quadrangular, hardly wider than long, with prominent, well rounded eyes and behind them strongly projecting, squarely cut hind angles; middle third of hind margin of head deeply excavated; ocelli very evident.

Prothorax closely fitted into excavation of rear of head. Antennae six jointed. Labium short, mentum a third longer than wide, considerably contracted at the base; median lobe not very prominent, serrulate on margin, with short, incurved, flattened microscopic scales arising between the serrulations; men-

tal setae four each side, lateral setae five (in one case six); end hook stout, arcuate, short, above which, on the distal margin of the lateral lobe and separated from the hook by a deep notch, are five minute teeth decreasing in size externally. Thorax narrower than head, wing cases reaching the base of segment 5 of abdomen; segments of the abdomen short, somewhat tapering to apex. Gills [pl.15, *c*] more than half as long as abdomen, lanceoval, widest in the middle, the superior border more convex than the inferior specially in the two lateral gill plates.

NEHALLENNIA

Two delicate bronzy green species are included in our fauna. One is widely distributed and well known; the other has not been hitherto reported from the State. These are among the most highly specialized of the Agrioninae, as evidenced by the reduced wing venation, the skewness of the thorax, the slenderness of the body, and the color. Reedy places in still water, specially places of springs and bogs, are their favorite haunts. I have bred our common species N. i r e n e , and describe its nymph below; the nymph of N. g r a c i l i s is unknown. The imagos may be distinguished as follows:

a Apex of the abdomen of the male with bronzy green lateral triangles laid on the blue of segments 8–10; hind margin of prothorax of female trilobed..... i r e n e

aa Apex of abdomen of male all blue on segments 9 and 10, and on segment 8 except a narrow basal ring; hind margin of prothorax of female bilobed.....g r a c i l i s

Nehallennia irene Hagen

Plate 18, fig. 4, 5

1861 A g r i o n i r e n e Hagen, Synopsis Neur. N. Am. p.74
1876 N e h a l l e n n i a i r e n e Selys, Acad. Belg. Bul. (2) 41:1240
1893 N e h a l l e n n i a i r e n e Calvert, Am. Ent. Soc. Trans. 20:234
1895 N e h a l l e n n i a i r e n e Calvert, N. Y. Ent. Soc. Jour. 3:43 (listed from Ithaca)
1899 N e h a l l e n n i a i r e n e Kellicott, Odon. Ohio, p.29
1900 N e h a l l e n n i a i r e n e Williamson, Dragon Flies Ind. p.265

This species is common about swales, springs and bogs in shallow reedy waters, associated with the bronzy green species of the genus Lestes, which dwell in the same situations. It is exceedingly common at Lake Forest Ill., where I bred a number of specimens June 7 and 8, 1899.

Nymph. Measures in length 12mm, gills 4 to 4.5mm additional; width of head 2.5mm. Color greenish, with faint brownish rings on the femora and five pairs of indistinct spots ranged along the margins of each gill lamella.

Head much wider than long, strongly narrowed behind the very prominent eyes to well rounded hind angles, whose curve is exactly the reverse of the concavity of the excavation of the hind margin between the hind angles. Legs slender, smooth; wing cases reaching the middle of the fourth abdominal segment. Gills [pl.15, *d*] lanceolate, pointed, widest a little beyond the middle, with more or less distinct small, marginal spots.

Antennae six jointed, the six joints having the following relative lengths:—1:2:3:2:1.7:2. Labium slender, the hinge reaching posteriorly about to the bases of the middle legs. Mentum not abruptly narrowed to the hinge, but with the lateral margins somewhat sinuate in outline. Mental setae 1 (and a rudiment) each side; lateral setae six each side. The end of the lateral lobe [pl.14, *i*] above the end hook not denticulate as in all the other genera.

Nehallennia gracilis Morse

1895 Nehallennia gracilis Morse, Psyche, 7:274

This species, hitherto reported from but two localities in Massachusetts, was common at Saranac Inn about the edges of Little Bog pond, where it was associated with N. irene, Lestes eurina, L. uncata, Cordulia shurtleffi, and Dorocordulia libera, a notable assemblage of bronzy greens. It swarmed about the edges of the clumps of lambkill, and could be taken anywhere by sweeping with a net the sedges and cotton grass that grew on the sphagnum beds. I regret I did not observe at the time that I was collecting anything but N. irene; and, having already bred that species, I made no effort to get the nymph of this one.

ENALLAGMA

This is the dominant genus among our Zygoptera. Twelve species have been recorded hitherto from the State; two other species (piscinarium and pollutum) are here recorded, and several other species are regional. These frequent all sorts of fresh water, being most abundant where there is much submerged and floating vegetation. They dwell in still and shallow water.

The imagos spend most of their time over the surface of the water, flying from leaf to leaf, or from one mat of floating algae to another. They fly very low, some species so low that it is well nigh impossible to get a collecting net under them without dipping the water. In foraging they fly through the vegetation—not over it, and do not often depart very far from the borders of the water. They flit easily about among the grass stems, where their bands of alternating brilliant blue and black are singularly inconspicuous, and they settle oftenest in a rigidly horizontal position on the perpendicular culms. So far as I have observed, their food is the small Diptera Chironomidae etc., which swarm in such places. They are eaten in numbers by cricket frogs, which lie in ambush amid the floating algae, and catch them when they come to mate and oviposit; by swallows, which can skim close enough to the water to get them, and they are snared in spider's webs, and are eaten by other damsel flies, specially by species of Lestes, as I have observed.

The eggs are deposited in punctures in the tissues of green plants just beneath the surface of the water. Floating leaves seem to be preferred, but, where these are absent, or too few, the stems of standing aquatics are often found thickly punctured, and filled with eggs in all stages of development. They generally fly in pairs and oviposit in *copulo*, but they do not, so far as I have observed, descend beneath the surface of the water in ovipositing.

The nymphs live in tangled, submerged vegetation, and are among the most numerous of the predatory hordes in such situations. They are protectively colored with green and brown, the proportion of each color varying somewhat with that of the surrounding vegetation. When grown, they crawl barely out of the water to transform. In places where there is more submerged than exposed vegetation, after a period of transformation, the exposed stems may often be found encircled with a mass of empty skins, clinging one above another where they have been left in a great accumulation, many layers deep.

It is highly probable that not all the species of the following enumeration will prove entirely distinct; but they have not yet

been studied and collected sufficiently for the determination of this matter. It would be utterly impossible at present to give a key that would distinguish females, and a key for the males based on coloration would have to be offered tentatively, since the range of variability in color pattern has not been determined. Instead of attempting a key, I have thought best to present herewith drawings of the appendages of the male of all species known from the State, these being the surest criteria for the recognition of the species. The males can then be determined by comparison with the figures, and the females can be kept with the males with which they are found associated in nature.

As is to be expected in such a genus, the nymphs are very much alike. A brief general description here will therefore save much repetition in treating of the species.

Nymph. The nymph of Enallagma is slender, nearly smooth, with the head a third wider than succeeding parts of the body (the excess of width being wholly due to the lateral prominence of the eyes), and with abdomen very slightly tapering posteriorly. The head is one half wider than long, with frons moderately prominent, broadly rounded hind angles, and a wide posterior excavation between them. Antennae long, slender, seven jointed, the segments increasing in length to the third, and decreasing thereafter to the tip. Legs slender, nearly smooth, often banded with brown. Wing cases reach posteriorly to the middle of the fourth abdominal segment. Abdomen cylindric, its segments decreasing a very little both in length and in diameter toward the apex. Gills lanceolate, pointed, with variable color pattern.

Fig 10 The nymph of Enallagma signatum: *A*, lateral view of median gill lamella.

Labium slender, with prominent median lobe, lateral lobes upcurved at their external margins; mental setae two to four each side. Lateral setae four to five each side. Lateral lobe with a moderate movable hook and an arcuate end hook and several small teeth on the distal end above the latter, of variable proportions.

Enallagma durum Hagen

1861 Agrion durum Hagen, Synopsis Neur. N. Am. p.87
1893 Enallagma durum Calvert, Am. Ent. Soc. Trans. 20:236, pl.3, fig.32

A species that is apparently not common in its range. It is recorded by Dr Calvert from Rhode Island and New Jersey, but

Fig. 11 Lateral view of end of abdomen of Enallagma durum, ♂

it has not yet, apparently, been taken in New York State. Its nymph is unknown.

Enallagma annexum

Plate 19, *a*

1861 Agrion annexum Hagen, Synopsis Neur. N. Am. p.87
1893 Enallagma cyathigerum, *var.* annexum Calvert, N. Y. Ent. Soc. Jour. 3:43 (listed from Keeseville and Ithaca)
1900 Enallagma annexum Williamson, Ent. News. 11:454, pl.9, fig.5, 9, 10 and text figure (characters and distribution)

A species with northward distribution. It was collected at Saranac Inn throughout July.

Enallagma hageni Walsh

Plate 19, *b*

1862 Agrion n. sp. Walsh, Acad. Nat. Sci. Phila. Proc. p.386
1863 Agrion Hageni Walsh, Ent. Soc. Phila. Proc. 2:234
1893 Enallagma hageni Calvert, Am. Ent. Soc. Trans. 20:237, pl.3, fig.22, 23
1895-97 Enallagma hageni Calvert, N. Y. Ent. Soc. Jour. 3:44 and 5:92 (recorded from Ithaca, Lake Bluff, Lake Pleasant, Albany and Squaw island)
1899 Enallagma hageni Kellicott, Odon. Ohio, p.39, fig.10
1900 Enallagma hageni Williamson, Dragon Flies Ind. p.269, pl.15. fig.1, 2

A species widely distributed in the eastern United States, and often locally very abundant. It is common at Ithaca about the Cascade pond during July, and about the hatchery grounds at Saranac Inn during the same month. I have bred the species at the following dates and places: Lake Forest Ill. May 31, 1899; Saranac Inn N. Y. July 15, 1900.

Nymph. Length 13mm; gills 4.5mm additional. Mental setae three each side. Lateral setae five each side. End hook of lateral lobe of labium preceded by three teeth of moderate size, that are preceded by three others very minute. Gills with scanty and diffuse pigmentation along the axial trachea in its basal two thirds.

Enallagma geminatum Kellicott

Plate 19, *c*

1895 Enallagma geminatum Kellicott, Ent. News, 6:239
1899 Enallagma geminatum Kellicott, Odon. Ohio, p.40, fig.11
1900 Enallagma geminatum Williamson, Dragon Flies Ind. p.272, pl.5, fig.11, 12 (recorded from New York)

This is a little species, which flies habitually within half an inch of the surface of the water, and is hard to get a net under. It appears to occur sparingly in New York State, but is abundant westward. I bred it at Havana Ill. in June 1896, at which time and place it was exceedingly abundant.

Nymph. Length 13mm, gills 4mm additional. Mental setae four (occasionally three) each side. Lateral setae five. Two minute teeth on the end of the lateral lobe, preceding the three usual larger ones before the end hook. Gills shorter than usual, and practically without pigmentation.

Enallagma divagans Selys

Plate 19, *e*

1876 Enallagma divagans Selys, Acad. Belg. Bul. (2) 41:521
1893 Enallagma divagans Calvert, Am. Ent. Soc. Trans. 20:238, pl.3, fig.15, 16
1899 Enallagma divagans Kellicott, Odon. Ohio, p.43, fig.12
1900 Enallagma divagans Williamson, Dragon Flies Ind. p.273, pl.5, fig.15, 16

This species is recorded from Massachusetts and Pennsylvania, but has not, apparently, been taken as yet in New York State. Its nymph is unknown.

Enallagma piscinarium Williamson

Plate 19, *d*

1900 Enallagma piscinarium Williamson, Dragon Flies Ind. p.273, fig.13, 14

This species was taken several times during July 1901 at Ithaca, by Mr H. N. Howland, Mrs O. A. Johannsen, and myself.

It was taken by Mrs Johannsen in an orchard in a city lot a considerable distance from water. The nymph is unknown.

Enallagma exsulans Hagen

Plate 16, fig. 2; plate 19, *f*

1861 Agrion exsulans Hagen, Synopsis Neur. N. Am. p.82
1893 Enallagma exsulans Calvert, Am. Ent. Soc. Trans. 20:238, pl.3, fig.29
1895–97 Enallagma exsulans Calvert, N. Y. Ent. Soc. Jour. 3:44 and 5:92 (listed from Keeseville, Saratoga lake, Ithaca, Black Rock)
1899 Enallagma exsulans Kellicott, Odon. Ohio, p.42, fig.1
1900 Enallagma exsulans Williamson, Dragon Flies Ind. p.274, pl.5, fig.17, 18

This is an exceedingly common species over the larger part of the eastern United States. At Ithaca it abounds everywhere. At Saranac Inn I found it most common about the trashy borders of the deeper ponds. I have bred the species at the following dates and places: Saranac Inn July 8, 1900, Galesburg Ill. June 30, 1895.

Nymph. Length 14.5mm, gills 4.5mm additional. Mental setae two or three on each side; lateral setae four or five. Three minute teeth preceding the normal three larger ones on the end of the lateral lobe above the end hook. Gills lanceolate but not very sharply pointed, pigmented in two transverse bands and along the axis and sometimes slightly around the margin.

Enallagma ebrium Hagen

Plate 19, *g*

1861 Agrion ebrium Hagen, Synopsis Neur. N. Am. p.89
1895–97 Enallagma ebrium Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from Keeseville, Ithaca, Schoharie and the Catskills)
1899 Enallagma ebrium Kellicott, Odon. Ohio, p.34, fig.5
1900 Enallagma ebrium Williamson, Dragon Flies Ind. p.270, pl.5, fig.3, 4

An abundant species in the Cascade pond at Ithaca, but I have neglected to rear it. Its nymph is unknown.

Enallagma carunculatum Morse

Plate 17, fig. 2; plate 19, *h*

1895 Enallagma carunculatum Morse, Psyche, 7:208
1895–97 Enallagma carunculatum Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from Niagara, Lake Pleasant and Piseco lake)

1898 Enallagma carunculatum Needham, Outdoor Studies, p.62, fig.62
1899 Enallagma carunculatum Kellicott, Odon. Ohio, p.38, fig.14
1900 Enallagma carunculatum Williamson, Dragon Flies Ind. p.270, pl.5, fig.7, 8

I bred this species at Havana Ill. July 10, 1896, where it was common about the banks of the Illinois river. It is a robust and handsome species, of somewhat stronger flight than most of its congeners.

Nymph. Length 15mm, gills 5mm additional. Mental setae three each side, laterals four to six, usually five. The three minute teeth on the end of the lateral lobe graduate into the three larger ones abutting on the end hook. Gills lanceolate, pointed, diffusely pigmented along the axis to near the tip.

Enallagma civile Hagen

Plate 19, *i*

1861 Agrion civile Hagen, Synopsis Neur. N. Am. p.88
1876 Agrion canadense Provancher, Nat. Canadienne, 8:125
1888 Enallagma civile Kolbe, Arch. f. Naturg. 44:170
1893 Enallagma civile Calvert, Am. Ent. Soc. Trans. 20:236, pl.3, fig.31
1895-97 Enallagma civile Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from "New York")
1899 Enallagma civile Kellicott, Odon. Ohio, p.37, fig.15
1900 Enallagma civile Williamson, Dragon Flies Ind. p.270, pl.5, fig.5, 6

A vigorous western species, apparently not common in New York State. Its nymph is unknown.

Enallagma aspersum Hagen

Plate 19, *j*

1861 Agrion aspersum Hagen, Synopsis Neur. N. Am. p.97
1893 Enallagma aspersum Calvert, Am. Ent. Soc. Trans. 20:237, pl.3, fig.30
1895 Enallagma aspersum Calvert, N. Y. Ent. Soc. Jour. 3:44 (listed from Long Island, Dobbs Ferry and New York city)
1895 Enallagma aspersum Morse, Psyche, 7:211
1899 Enallagma aspersum Kellicott, Odon. Ohio, p.25, fig.2
1900 Enallagma aspersum Williamson, Dragon Flies Ind. p.271

A species I have not seen at large. Its nymph is unknown.

Enallagma antennatum Say

Plate 16, fig. 4; plate 19, *l*

1839 Agrion antennatum Say, Acad. Nat. Sci. Phila. Jour. 8:39
1861 Protoneura antennata Hagen, Synopsis Neur. N. Am. p.73
1895 Enallagma fischeri Kellicott, Cincinnati Soc. Nat. Hist. Jour. 17:206
1897 Enallagma fischeri Calvert, N. Y. Ent. Soc. Jour. 5:94 (listed from Ithaca)
1900 Enallagma antennatum Williamson, Dragon Flies Ind. p.274, pl.5, fig.19, 20

In April Mr E. B. Williamson sent me from Bluffton Ind., and Mr R. J. Weith sent me from Elkhart Ind., simultaneously, nymphs (one of which is shown on plate 16, figure 4) that I suspected might belong to this species. Mr Williamson had volunteered to rear the species for me, and early in June he reported that he had done so, and that it was E. antennatum. The nymph differs from others of the genus in the striking zigzag lines of pigmentation across the eyes, in a poorer development of the mental setae of the labium and in the shape and color pattern of the gills.

Nymph [pl.16, fig.4]. Measures (not fully grown) in length 12mm, gills 5mm additional. Colors green and brown, disk of head and a middorsal longitudinal line on prothorax, narrowing posteriorly, pale; there is also an oblique pale line starting behind each eye on the sides of the prothorax. The pigmentation of the eye is in well marked zigzag lines extending horizontally. Legs pale, with subapical rings of brown on all femora. There is a narrow pale middorsal line on the abdomen and a paler wash on the lateral angles of all the segments. The antennae are but six jointed but I suspect that this may be due to immaturity; the two basal segments are brown, the remainder, pale.

Gills lanceolate, unusually long and narrow, widest just beyond the middle, obscurely marked with brown, which is deepest in shade just before the white tips.

Labium with five lateral setae, and three mentals each side, of which one is minute: thus the development of mental setae is less than in any other species at present known to me.

I have collected a single male specimen at Ithaca.

Enallagma traviatum Selys

Plate 19, *k*

1876 Enallagma traviatum Selys, Acad. Belg. Bul. (2) 41:519
1895 Enallagma traviatum Calvert, N. Y. Ent. Soc. Jour. 3:44 (listed from Long Island)

1895 Enallagma traviatum Morse, Psyche, 7:211
1899 Enallagma traviatum Kellicott, Odon. Ohio, p.36, fig.8, 9
1900 Enallagma traviatum Williamson, Dragon Flies Ind. p.271, fig. 9, 10

Another species I have not seen at large. Its nymph is unknown.

Enallagma signatum Hagen

Plate 17, fig. 2; plate 19, *m;* text figures 10, 11

1861 Agrion signatum Hagen, Synopsis Neur. N. Am. p.84
1863 Agrion dentiferum Walsh, Ent. Soc. Phila. Proc. 2:236
1893 Enallagma signatum Calvert, Am. Ent. Soc. Trans. 20:238, pl.3, fig.28
1895-97 Enallagma signatum Calvert, N. Y. Ent. Soc. Jour. 3:44 and 5:92 (listed from New York and Williamsville)
1899 Enallagma signatum Kellicott, Odon. Ohio, p.45, fig.4
1900 Enallagma signatum Williamson, Dragon Flies Ind. p.5, fig.21, 22

To the foregoing record for this species I can add that it occurs sparingly at Ithaca. I have bred it repeatedly in Illinois in June, and have its nymph also from North Carolina.

Nymph [fig.10]. Length 14.3mm, gills 5mm additional. Mental setae three each side; laterals five, or in young nymphs four. An indistinctly denticulate lobe preceding the three well defined normal teeth on the end of the lateral lobe of the labium above its end hook. Gills elongate lanceolate, pointed, with three broad transverse well defined blackish bands connected with black on the axis, the apical one broader.

Enallagma pollutum Hagen

Plate 19, *n*

1861 Agrion pollutum Hagen, Synopsis Neur. N. Am. p.83
1893 Enallagma pollutum Calvert, Am. Ent. Soc. Trans. 20:239, pl.3, fig.27
1899 Enallagma pollutum Kellicott, Odon. Ohio, p.46, fig.13
1900 Enallagma pollutum Williamson, Dragon Flies Ind. p.276, pl.5, fig.23, 24

Though the range of this species extends from Maine to Florida and Illinois, it has not hitherto been reported from New York State. Its nymph is unknown.

Three additional species from Massachusetts, E. laterale, E. minusculum and E. pictum, described by Morse in *Psyche*, 7:207, 274 respectively, and unknown to me, may, perhaps, be counted regional.

ISCHNURA

This cosmopolitan genus contains a few very common and widely distributed and well known species. I include three in this paper, one of which I. posita, has been referred hitherto

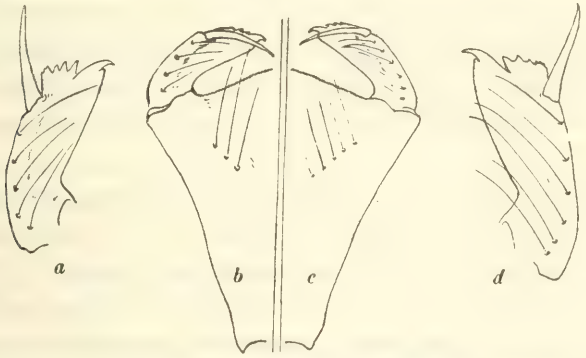


Fig. 12 Labia of Enallagma and Ischnura; *a* and *b*, labium of E. signatum; *c* and *d*, of I. verticalis

to Nehallennia. The one reason for referring it to Nehallennia, the absence of a spine on the apex of the sternum of the eighth abdominal segment in the female, appears not to be a

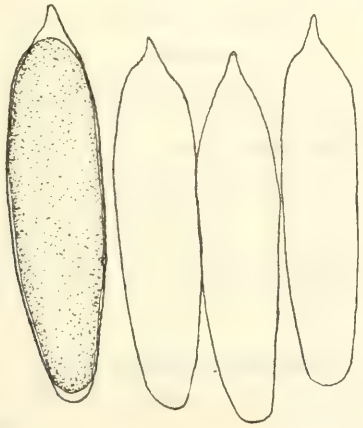


Fig. 13 Eggs of Ischnura verticalis

good one, since a number of species are now referred to Ischnura lacking that spine. Ischnura and Enallagma are not very sharply defined from each other, and this troublesome species stands in some respects intermediate in characters between the

two; but I have here referred it to Ischnura chiefly because of the form of the abdominal appendages in the male, and the small round postocular spots. Its nymph I am not as yet able to separate from those of several species of Enallagma. I. verticalis, seems, on the contrary, to be distinguishable by the possession of six lateral setae in the nymphal labium; I have seen one specimen of E. carunculatum with this number on one side, but no other specimen of Enallagma with more than five.

The species of Ischnura appear early in spring, being often the first to be seen, and continue till late autumn, and have probably a number of overlapping broods each season. They frequent all sorts of fresh and even somewhat brackish water, and flit lightly around the shores, ovipositing in the stems of half submerged water plants, or they forage somewhat widely over the adjacent hill slopes.

The nymphs likewise occur everywhere in water in which there are stems of water plants to clamber on.

Our species may be distinguished as follows:

KEY TO SPECIES

Imagos

a Segments 8 and 9 of abdomen blue with a black stripe each side ..... verticalis
aa Segment 8 of abdomen blue, 9 black ..... ramburii
aaa Segments 8 and 9 of abdomen black ..... posita

Nymphs

a Labium with six lateral setae each side ..... verticalis
aa Lateral lobe of labium with five lateral setae ..... posita
aaa Unknown ..... ramburii

Ischnura verticalis Say

Plate 16, fig. 5; plate 17, fig. 4, 5

1839 Agrion verticalis Say, Acad. Nat. Sci. Phila. Jour. 8:37
1861 Agrion verticalis et Agrion ramburii Hagen, Synopsis Neur. N. Am. p.76 and 82
1893 Ischnura verticalis Calvert, Am. Ent. Soc. Trans. 20:239
1895–97 Ischnura verticalis Calvert, N. Y. Ent. Soc. Jour. 3:44 and 5:92 (listed from most parts of the State)
1898 Ischnura verticalis Davis, N. Y. Ent. Soc. Jour. 6:196 (listed from Staten Island)

1898 Ischnura verticalis Needham, Outdoor Studies, p.61, fig.61
1899 Ischnura verticalis Kellicott, Odon. Ohio, p.48
1900 Ischnura verticalis Williamson, Dragon Flies Ind. p.278

This pretty little species is perhaps the commonest damsel fly in North America. It is everywhere common in this State, ranges through the whole season, and is out early in the morning and flies till dusk. It will be readily recognized in the male sex by the black bars on a blue ground on the sides of the eighth and ninth abdominal segments.

I have bred the species at every station where I have done any extended collecting, and at various dates, but oftenest in June and July.

Nymph. Measures in total length 11mm; gills 5mm additional. Color greenish, paler beneath and on the sutures with darker mottlings on the top of the head, and more or less distinct subapical rings on the femora; abdominal segments with darker apical rings including a circlet of pale dots; gills hyaline with tracheae showing very distinctly and pigmentation tending to form incomplete transverse bands of blackish brown.

Antennae seven jointed. Labium with six lateral and four mental setae each side; end of lateral lobe with three distinct and strong teeth above the end hook and a denticulate angle next the movable hook.

Ischnura ramburii

1850 Agrion ramburii Selys, Rev. Odon. d'Eur. p.186
1876 Ischnura ramburii Selys, Acad. Belg. Bul. (2) 41:272
1861 Agrion iners
Agrion tuberculatum
Agrion credulum
Hagen, Synopsis Neur. N. Am. p.75, 76, 80
1893 Ischnura ramburii Calvert, Am. Ent. Soc. Trans. 20:240
1895 Ischnura ramburii Calvert, N. Y. Ent. Soc. Jour. 3:44 (listed from New York)
1898 Ischnura ramburii Davis, N. Y. Ent. Soc. Jour. 6:196 (listed from Staten Island)

A species apparently with coastwise distribution. Its nymph is unknown.

Ischnura posita Hagen

1861 Agrion positum Hagen, Synopsis Neur. N. Am. p.77
1867 Nehallennia positum Selys, Acad. Belg. Bul. (2) 41:1242
1893 Nehallennia posita Calvert, Am. Ent. Soc. Trans. 20:235

1898 Nehallennia posita Davis, N. Y. Ent. Soc. Jour. 6:196 (listed from Staten Island)
1899 Nehallennia posita Kellicott, Odon. Ohio, p.30
1900 Nehallennia posita Williamson, Dragon Flies Ind. p.266

This species is of wide distribution, and is probably much more common than our present records indicate. It has hitherto been reported only from Staten Island. I have taken it at Ithaca. I bred a single specimen at Galesburg Ill. in June 1896. The cast skin is lacking in gills, and is distinguishable from that of I. verticalis only by its smaller number of raptorial setae; five laterals and four mentals, each side; in this, approaching Enallagma, as already mentioned. Another specimen not bred but apparently of this species, has the gills as slender as in Anomalagrion [pl.15, *e*], an interrupted line of blackish dashes along the axis; a spot before the middle followed by a blackish crescent band.

ANOMALAGRION

There is a single species.

Anomalagrion hastatum Say

Plate 18, fig. 6, 7

1838 Agrion hastatum Say, Acad. Nat. Sci. Phila. Jour. 8:38
1857 Agrion hastatum Selys, Sagra's Hist. Cuban Ins. p.469
1876 Anomalagrion hastatum Selys, Acad. Belg. Bul. (2) 41:255
1893 Anomalagrion hastatum Calvert, Am. Ent. Soc. Trans. 20:240
1895 Anomalagrion hastatum Calvert, N. Y. Ent. Soc. Jour. 3:44 (listed from Keeseville and New York city)
1898 Anomalagrion hastatum Davis, N. Y. Ent. Soc. Jour. 6:196 (listed from Staten Island)
1899 Anomalagrion hastatum Kellicott, Odon. Ohio, p.49
1900 Anomalagrion hastatum Williamson, Dragon Flies Ind. p.279

This exceedingly delicate species is widely distributed in North America, but everywhere very local. I have found it in two places only, in very restricted areas of a few square meters each. In both there was a dense growth of small club-rushes, with cool spring water filtering through them. Among the club-rush stems the linear yellow bodies of these insects are very inconspicuous. They do not appear to fly above or to depart from their native rush patches.

I bred the species at Galesburg Ill. in June 1896, and Prof. C. F. Baker bred it at Auburn Ala. May 15, 1897, and sent me a male imago with its cast skin.

Nymph. Measures in length 8mm, gills barely 4mm additional; width of head 2.3mm.

Color greenish or blackish brown, paler on the legs, on the distal two thirds of the antennae, and on the sutures. Clearly marked specimens show on the pale upper surface of the head a narrow line of brown each side extending from the eye almost to the median line parallel to the hind margin; in front of which a broader and less well defined band extends between the eyes on top of the head. From the head there extends posteriorly to the end of the abdomen a dorsal, indistinct median band, divided by a very narrow median line. There are interrupted lines of black on the carinae of the femora and tibiae, very narrow. Gills [pl.15, *c*] pale with interrupted pigmentation, tending to form diffuse blotches, the most prominent of which is just before the middle of the gill.

Body slender. Head compact, with eyes prominent, obtusely rounded, scurfy, hairy hind angles, and deeply and roundly excavate on hind margin. Legs slender. Wings reaching the base of the fourth abdominal segment. Abdomen a little longer than the gills. Gills lanceolate, long pointed, nearly bilaterally symmetric, widest just beyond the middle.

Antennae seven jointed, the relative length of the joints being as follows in order from the base: 1:1.3:2:1.3:1.5:1.4:1.2:1. Labium of moderate length, mentum not strongly contracted at base, median lobe prominent, fringed with microscopic scales so arranged as to give a serrate edge, mental setae four and often a small rudiment of a fifth, lateral setae [pl.14, *j*] five, movable hook short, arcuate, end hook blunt, and above it on the end of the lateral lobe, three well defined teeth, and above them a denticulate angular prominence.

APPENDIX ON ODONATA

During the past season there has been opportunity for making some further observations on the Odonata-Anisoptera; and in the lapse of time since Bulletin 47 was issued collections have been received from a number of friends, and among the specimens received are a number of nymphs of species belonging to the New York fauna. It is now possible to add descriptions of the nymphs of 11 additional species, with new data on some

of the others, together with a few corrections. Dr P. P. Calvert has generously offered for publication here additional data on the distribution of the New York species of Odonata, accumulated since the publication of the second instalment of his list. In bringing such data together in one place, he shows commendable regard for the convenience of the student of our local fauna.

1 ANISOPTERA

ADDITIONAL NOTES WITH DESCRIPTIONS OF HITHERTO UNKNOWN NYMPHS

Hagenius brevistylus, Lanthus parvulus and Dromogomphus spinosus

A number of cast nymph skins of each of these species were found on the stone embankment at the outlet of Forest lake (Fall creek, Ithaca) on my arrival in the latter part of June. A female imago of L. p a r v u l u s was found in a mass of foam floating on the water at the foot of a little fall in Fall creek July 9.

Gomphus fraternus

The species to which I have several times referred by this name in print[1] as coming from Havana Ill. was so determined for the Illinois State Laboratory of Natural History by Dr Hagen from material obtained from that locality. It appears from a recent study of this and closely related species by Dr P. P. Calvert[2] that Dr Hagen made a mistake in naming it so. The Havana species is G. e x t e r n u s, and, as may be inferred from the fact that Dr Hagen confused the two species, they are exceedingly closely related. I was unable to use Dr Calvert's paper in the preparation of Bulletin 47, and the description I have given therein on p.451 is drawn from specimens of G. e x t e r n u s. It will apply equally well to the nymph of G. f r a t e r n u s. I took the latter species in transformation at Ottawa Ill. on May 24, and have since had bred specimens for study from the United States National Museum, collected at Detroit Mich. It has re-

[1]Canadian Ent. 29:164, 165, pl.7, fig.11 and 12. N. Y. State Mus. Bul. 47, p.451, pl.20, fig.11 and 12.

[2]On G o m p h u s f r a t e r n u s, e x t e r n u s and c r a s s u s (Order Odonata), Ent. News. 12:65–73, pl.3.

quired an unusually careful examination of the nymphs of the two species to detect any differences whatever. I find only the following, and am not assured as to how constant these will prove. (1) The front border of the median lobe of the labium in e x t e r n u s is slightly but distinctly convex [*see* Bul. 47, pl. 20, fig.12]; in f r a t e r n u s it is straight or scarcely convex. This is probably a good character. (2) The lateral spines of the ninth abdominal segment are something more than two times the length of the tenth segment in e x t e r n u s ; in f r a t e r n u s they are something less than two times the length of the tenth segment.

Gomphus borealis

I now regard this as a species, and not a variety of G. d e s c r i p t u s . I described it as a variety because I was unable to give any satisfactory character for the separation of females; but a more careful examination of my specimens reveals differences in the form of the hind margin of the occiput, that appear to be reliable. In the female of b o r e a l i s the occipital margin viewed from the front exhibits two low, rounded lobes, between which is a depression whose curvature is exactly the reverse of the convexity of the lobes. In the female of d e s c r i p t u s the occipital margin is scarcely bilobed, and the median half of it is straight, not concave in the center at least. Comparing the nymphs again, d e s c r i p t u s nymphs from Ithaca with b o r e a l i s nymphs from Saranac Inn, I find that the lateral spines of the sixth abdominal segment in b o r e a l i s are half as long as those of the seventh segment; in d e s c r i p t u s , about equal in length on these segments.

GOMPHURUS

This subgeneric name I have used as a convenient designation for the d i l a t a t u s group of Selys. Mr Williamson has included some of its species in Stylurus[1], but I prefer as yet to restrict that name to the very homogeneous group of species whose separateness was indicated by Hagen in the *Transactions*

[1]Amer. Ent. Soc. Trans. 27:205-17.

of the American Entomological Society, 12:269, and for which the name was afterward proposed. Since I have merely applied a name to one of Selys's groups of species, I regard G. dilatatus as the type of Gomphurus, fixed by Selys's usage. I have received from Mr. R. Weith, of Elkhart Ind., a cast skin that can belong to none other than this huge species. I give a description herewith.

Nymph. Length 38mm, abdomen 22mm, hind femur 7mm; width of head 6.2mm, of abdomen 10mm. Body strongly depressed, with wide abdomen; skin granulate, but little hairy except on the sides of the head, antennae and tibiae; antenna with its third segment thrice as long as the two first segments together; labium rather small; median lobe in front with a deep semicircular concavity, the sides of which are thinly fringed with flattened hairs or scales; lateral lobes strongly hooked on the outer end, and with about six low, irregular, obliquely truncated teeth on the basal two thirds of the concave inner margin; burrowing hooks of the fore and middle tibiae very large, triangular, as long as the greatest diameter of the tibia; dorsal hooks of the abdominal segments very rudimentary, on segments 7–9 only, becoming better defined on these segments successively; lateral spines on segments 6–9, strong, increasing in size posteriorly, those of the ninth segment twice as long as the tenth segment; superior and lateral appendages paler dorsally, the laterals one fourth shorter than the superior.

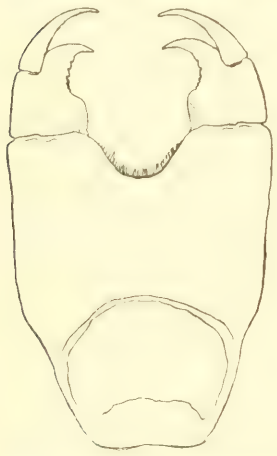


Fig. 14 Labium of the nymph of Gomphus dilatatus

Gomphus spicatus

The nymph which I described as belonging to this species in Bulletin 47, page 459 does not belong to it. To what it may belong I am quite uncertain; perhaps, to G. furcifer; perhaps to some as yet unknown species. The description of the true G. spicatus nymph will be found in the Illinois State Laboratory of Natural History bulletin, 1901, 6:76.

Gomphus furcifer

Mr T. H. Hankinson took a specimen of this species on the Renwick flats at Ithaca in July 1901, thus establishing the fact that the species belongs to the Ithaca fauna.

Gomphus notatus

This species and G. plagiatus are very closely related. Both are likely to be found in the State eventually. I have recently had bred specimens of notatus for study from the United States National Museum, and from Mr E. B. Williamson, the former from Detroit Mich. and the latter from Nashville Tenn. The differences between the nymphs of the two species are so slight that they will be appreciated with difficulty by a novice. They are as follows: (1) In notatus the ninth abdominal segment is more than five times as long as the tenth segment; in plagiatus, less than five times as long. (2) The two to three obliquely truncated teeth on the inner margin of the lateral lobe of the labium are twice as big in notatus as in plagiatus [*see* Bul. 47, pl.20, fig.16]. (3) The rudiment of a dorsal hook on the apex of the ninth abdominal segment is a little better defined in notatus.

Gomphus spiniceps

A nymph of this species was taken from Forest lake, Ithaca, by Mr O. A. Johannsen, in July 1902, and reared.

Gomphus descriptus

Corrections. In Bulletin 47, page 454, there are stated to be six to eight teeth on the inner margin of the lateral lobe of the labium of the nymph of this species; the number should be eight to ten as given in the key on page 446.

On page 436 the word "tarsi" in line *aa* in the key at the bottom of the page should read "femora."

CORDULEGASTERINAE

Cordulegaster sayi

I have received nymphs from Mr C. S. Brimley of Raleigh N. C. that should belong to this species, because of their locality and their very close resemblance to those of C. diastatops.

Nymph. Length 34mm, abdomen 24–25mm, hind femur 4.5mm; width of head 7.5mm, of abdomen 8mm.

Head broad, concave between the eyes, and with a prominent rounded frontal shelf, whose border is fringed with stiff hairs; eyes capping the anterolateral angles of the head; sides of the head bulging behind the eyes, and regularly rounded to the slightly concave middle hind margin, scurfy hairy; thorax and bases of the legs very hairy; disk of the prothoracic dorsum produced laterally at its ends into thin, shelflike, bristle-fringed lobes.

Face blackish; sides of the mesothorax and metathorax brown, divided by a broad, vertical paler stripe (an indication of the

Fig. 15 Labium of the nymph of Cordulegaster sayi (supposition)

adult color pattern, that is apt to be absent in younger nymphs); wing cases with darker pigmentation on the nodus and at the stigma; abdomen with a pale, middorsal line, bordered at either side with a row of large, brown spots, a pair on each segment, best defined on segments 7 and 8 and largest on segment 8. Between these rows and the lateral margins on each side are two additional equidistant rows of ill defined spots, and the apical angles of each segment are washed with brown. Abdomen little hairy beyond the middle, much less so than in diastatops; stout, straight, conspicuous lateral spines on segments 8 and 9; appendages yellow, black tipped and with a copious fringe of black hairs on their internal margins.

Labium [fig.15] of the usual large size and spoon-shaped form, with five lateral setae and 11 mentals each side, the six outer-

most of the mentals in a stronger series. Median labial lobe fringed except in the middle, where there is the usual bifid median tooth, each half of which in this species and in d i a s t a t o p s is again bifid; but in this species it is about equally bifid, i. e. the two lobes thus formed are about equal in size, while in d i a s t a t o p s the lower lobe is much smaller, scarcely rising above the level of the fringe.

CORDULIINAE

SOMATOCHLORA

Since Bulletin 47 was written, I have obtained nymphs of two additional species of Somatochlora; and, while neither of them is bred, I deem it worth while to describe them now, in order that the new characters they present may allow a better defining of the genus. The characters which I stated with due caution in the table of nymphs (*loc. cit.* p. 485) now need amplification in but one minor particular: the dorsal hooks, while not cultriform, may be, as in these two species, sharply pointed.

Somatochlora sp.? no. 2

Length 24mm, abdomen 15mm, hind femur 8mm, antenna 6mm; width of head 6.2mm, of abdomen 8mm.

Body stout, moderately depressed, very hairy on the antennae, sides of head and thorax, legs and base of abdomen; head wider than long, eyes small, capping the anterolateral angles; head narrowed behind the eyes to the broadly concave hind margin; legs slender, with faint, subapical rings of brown on the femora; wing cases reaching the base of the sixth abdominal segment; abdomen triquetral, widest on segment 6, slightly narrowed on 7, more narrowed on 8, strongly narrowed on 9, in so much that segment 10 is less than half as wide as 9 at base; segment 10 very short, annular, included in the dorsally emarginate apex of 9; appendages as long as segments 9 and 10 together, the inferiors slightly longest and the superior a very little longer than the laterals; lateral spines on segments 8 and 9 equal in length to one third or one fourth of the length of their respective segments, those of the ninth hardly longer than those of the eighth segment; dorsal hooks on segments 4–9 similar, but stouter on segments 7–8, and spinulose on their very convex, superior margins on 6–9 (their inferior margin viewed laterally).

Labium with seven lateral setae and 11–12 mental setae, each side of which the fifth (counting from the side) is longest, and the outermost 7–8 constitute a stronger series. Teeth on the

opposed margins of the lateral lobes inrolled, moderately well marked, each about 4 spinulose.

On the middle of the sides of the abdomen are two longitudinal brownish bands, below which the sides are paler.

One specimen, collected by Mr T. H. Hankinson near Varna, 2 miles above Ithaca, from a cold spring brook near to the place of its confluence with Fall creek, July 13, 1901. I collected a specimen of the same species in Six Mile creek a mile southeast of Ithaca in April 1896. I innocently placed it in a breeding cage in which were a few Gomphus nymphs burrowing in the mud of the bottom; for I did not then know that Gomphus nymphs go foraging in the territory above them. The next morning there remained in my cage but a fragment of the Somatochlora nymph, consisting of the dorsal wall of the abdomen and the abdominal appendages. This fragment I preserved, for I had recognized that the nymph was a new one, and I find it quite sufficient for recognition as the same species described above. The dorsal hooks are perhaps twice as long in this species as in S. elongata. Since S. elongata is the only species known from Ithaca, I am unable to say to what species this nymph may belong.

Somatochlora sp. no. 3

A single nymph, not fully grown, sent me from Raleigh N. C. by Mr C. S. Brimley. It is a short, flat species with very wide, abruptly truncated abdomen. Somatochlora tenebrosa has been collected at Raleigh, and the nymph may belong to that species.

Length 16mm, abdomen 9mm, hind femur 5.5mm, antenna 6mm; width of head 5mm, of abdomen 8mm. In form and ornamentation of the head and front part of the body and in armature of the labium similar to the preceding species. Differs in the relatively greater width and flatness of the abdomen, in having the lateral spines of segments 8 and 9 wider, flatter, blunter and straighter at tip, and triangular in outline as seen from above; appendages shorter and more retracted, the tip of the laterals hardly surpassing the level of the tips of the lateral spines of the ninth segment (surpassing these by half their length in the preceding species). Dorsal hooks shorter, on segment 4 a mere rudiment, on 5 small, on 6–9 better developed, spinulose on superior and straight and bare on inferior margins.

LIBELLULINAE

Sympetrum corruptum Hagen

Prof. T. D. A. Cockerell took this species in transformation at Tempe Ariz. on Salt river Mar. 30, 1902, and kindly sent me specimens which he has allowed me to describe herewith. He sent me also a single male with its cast nymphal skin labeled Las Vegas N. M., October 1901. Thus we have the life history of this species from the western end of its range, and, though coming from an unexpected quarter, it makes a very desirable addition to our knowledge of the fauna of the State. In New

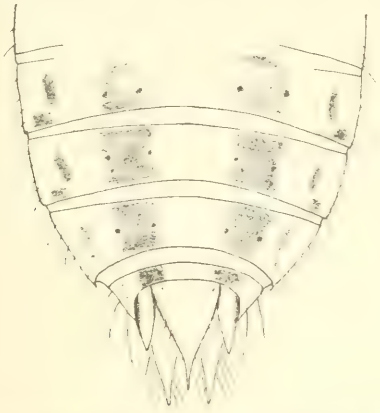


Fig. 16 End of abdomen of nymph of Sympetrum corruptum

York State this species flies only in late summer and autumn (in early spring I have twice found a specimen that, I suppose, had hibernated); but in the southwest it flies throughout the greater part of the season.

Nymph. Length 19mm, abdomen 11mm, hind femur 4.5mm; width of head 4.5mm, of abdomen 6mm. Body stout, little depressed, sparsely hairy on the rear of the head, the outer margins of the tibiae and the apex of the abdomen. Head much wider than long, with prominent eyes directed forward and almost angulate anterolaterally; sides sloping behind the eyes to the nearly straight hind margin, and scurfy hairy; top of head with six longitudinal, scurfy hairy lines behind the transverse suture.

Dorsum of the thorax fuscous, divided by a narrow longitudinal, pale line; the sides with some ill defined fuscous markings; legs pale.

Abdomen with a pair of broad, dorsal fuscous stripes interrupted on the sutures, extending posteriorly to end at the bases of the lateral appendages on each side, including a pair of transversely placed darker spots [fig.16]. On each side, half way from this band to the lateral margin, there are on each segment a pair of brownish marks, of which the lower one is transversely placed and rests on the apical carina of the segment; each lateral appendage is black on its lateral margins.

No dorsal hooks at all. Lateral spines almost wanting, represented only on the ninth segment by a very minute tooth, which

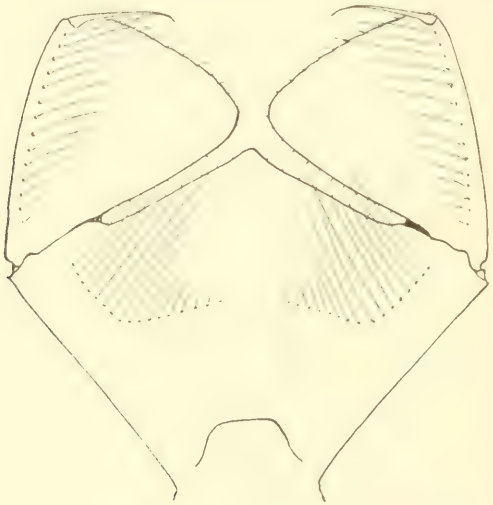


Fig. 17 Labium of Sympetrum corruptum

continues the inward slope of the lateral margin. Sides of abdomen nearly parallel on segments 4-7, slightly narrowed posteriorly on 8, strongly narrowed on 9; 10 annular, included, one fourth to one third as long as 9; superior appendages as long as segments 9 and 10 together, lateral appendages fully one third shorter than the others; the lateral and ventral margins of segments 9 and 10 very hairy.

This species differs from its nearest relative, S. illotum, (1) in having 13-14 lateral setae on its labium [*see* fig.17], in S. illotum there are but 9; (2) in having about 17 mental setae, each side of which there are nine in the stronger outer series—in illotum there are about 13, and seven in the stronger outer rank; (3) in having the lateral spines even less developed; (4) in having a better developed color pattern. Except in these particulars the nymph of S. illotum (of which

I have a number of specimens kindly communicated by Prof. V. L. Kellogg, of Stanford University) is very similar. In both these species the labial hinge reaches posteriorly between the bases of the middle legs.

These two southwestern species are at least subgenerically distinct from our eastern species; but a study of the not very homogeneous palearctic species should precede any attempt at the division of the genus.

LIBELLULA

Of the nine species of this genus which I listed from New York State in Bulletin 47, the nymphs of four were unknown. I believe I have the nymphs of two of these, though neither has been bred, and I describe them below.

Libellula axillena (supposition)

A single nymph not fully grown, from Raleigh N. C., collected by Mr C. S. Brimley.

Length 22mm, abdomen 14mm, hind femur 5mm; width of h ad 5mm, of abdomen 7.2mm. Very similar to the nymph of L. a u r i p e n n i s; having sharp pointed dorsal hooks on abdominal segments 4-8 and five setae on the lateral lobe of the labium, it would be traced to that species by my key (loc. cit. p.532); but it differs in the following particulars. (1) The mental setae are 12-13 each side, the six to seven outermost larger and closer together than the others. (2) The lateral spines of the eighth and ninth abdominal segments are less distinctly incurvate at tip and bear finer bristles on their external margin. (3) The lateral abdominal appendages (white with black margins) are but a third as long as the inferiors (they are one half as long in a u r i p e n n i s). There is also in this nymph a black band across the head between the eyes; there are subapical bands on the femora.

Libellula cyanea

I have received numerous specimens of this nymph from Newark and Cooch Del., sent by Prof. E. D. Sanderson, and from Raleigh N. C., sent by Mr C. S. Brimley. These nymphs all show (what I did not see in the cast skins I described) a submedian, ventral double row of round, small, brown dots; there is a corresponding double dorsal row of plainer dots ending opposite the lateral appendages, and between the two lines of

dots on the dorsal side is a double row of broader, obscurer brownish marks close beside the middle pale line. The number of lateral setae appears to be somewhat variable: while six is the normal number, seven occur sometimes; but the species is in such cases distinguishable from b a s a l i s by the brown markings just described.

Libellula plumbea (supposition)

I have a single specimen of this species, received from Mr C. S. Brimley of Raleigh N. C. It is very similar to the nymph of L. c y a n e a, but is at once distinguished by the p ss ssion of eight lateral setae on the labium.

Length 17mm, abdomen 10mm, hind femur 5mm; width of head 5mm, of abdomen 7mm (not fully grown). Head with an anvil-shaped black mark on either side of the median ocellus; a pale median line extends from the median suture of the head to the base of the abdomen; segments 2-8 of abdomen each with a pair of large, oblique, brown spots on the sides, becoming diffuse on 7 and 8 and the apical portion of each becoming detached as a darker, small, round dot; there is also an outer row of dots blacker on segments 4-9; femora and tibiae faintly twice banded. There are four lines of pubescence each side down the back of the head.

Lateral setae of labium 8, mentals 12-13, each side of which the outer seven are in a larger series. Dorsal hooks of abdomen on segments 4-8, spinelike on 6-8, and straight on the superior margin differing in this from nymphs of b a s a l i s, in which the apexes are declined and the upper margin arcuate). The superior appendage is longer and more contracted in the middle and more attenuate to the apex than in b a s a l i s.

I conclude my part of this appendix with a tabular statement of the general features of the habitat of such New York species as I have had good opportunity for observing in the field. Further observation will probably discover that some of these have a wider range of habitat; but I trust that this table contains hints that will be of use to the amateur collector. My record for brackish water species is based on a small collection from Sable island sent me by Dr James Fletcher. There is no fresh water there; and the material sent included cast nymphal skins of the two species listed here, taken on the spot.

Habitat of some New York Odonata

SPECIES OBSERVED	RAPID STREAMS			Slow streams	Rivulets	Lakes	Ponds	MARSHES		
	Rapids	Beds	Edges of current					Springy	Stagnant	Brackish
P. obscurus	x	x								
O. aspersus	x	x								
O. carolus	x	x								
H. brevistylus		x								
L. parvulus		x								
G. abbreviatus		x								
G. brevis		x								
G. fraternus				x						
G. descriptus		x								
G. sordidus		x								
G. exilis		x		x		x	x			
G. scudderi		x								
G. plagiatus						x				
G. spiniceps		x								
G. spicatus		x		x			x			
G. villosipes		x		x						
D. spinosus						x				
B. vinosa			x	x		x				
B. janata			x							
N. pentacantha			x							
A. constricta				x		x	x			
A. junius				x		x	x		x	x
C. maculatus		x								
C. diastatops					?			x		
D. transversa		x		x						
E. princeps				x		x	x			
T. spinigera, cynosura				x		x	x			
H. uhleri								x		
S. elongata						x	x			
D. libera							x			
N. bella									x	
P. domitia							x		x	
C. eponina				x		x	x			
C. elisa						x	x			
L. intacta, glacialis							x		x	
S. corruptum, rubicundulum, etc.							x		x	
P. longipennis							x		x	
M. simplicicollis							x		x	
L. julia						x	x			
L. basalis, pulchella				x		x	x			
P. lydia				x		x	x			
T. lacerata						x	x			
P. flavescens						x	x			
H. americana	x		x							
C. maculata	x		x	x						
L. eurina, uncata, forcipata, etc.							x	x	x	
A. putrida	x		x							
A. apicalis				x			x			
A. violacea				x					x	
C. conditum						x	x	x		
A. saucium					x					
N. irene							x		x	
E. hageni, signatum etc.				x		x	x		x	
I. verticalis				x	x	x	x	x	x	x
A. hastatum								x		

It certainly is not without interest one observes in glancing over this table that while the majority of the species live in ponds or still water, the more generalized members of both suborders live in rapids of streams.

The species of which nymphs are newly characterized in this appendix are[1]:

Gomphus fraternus*
Gomphus borealis
Gomphus dilatatus
Gomphus notatus*
Cordulegaster sayi
Somatochlora, sp. no. 2
Somatochlora, sp. no. 3
Sympetrum corruptum*
Sympetrum illotum*
Libellula axillena
Libellula plumbea

Distribution of New York dragon flies

ADDITIONAL DATA[2]

By Dr P. P. Calvert

Lestes vigilax. Folwood lake, July 22; Knapp pond, July 30; Stevensville lake, Aug. 1; Amber lake, Aug. 2; Black lake, Aug. 2; Beaver brook, Aug. 3; Stump pond, Aug. 3; Green lake, Aug. 28; Catskill lake, Aug. 30.

Lestes disjuncta. Hunter's pond, July 30; Mud pond, July 30; Beaver brook, Aug. 3; Burnt Hill pond, July 29; Catskill lake, Aug. 30 (abundant).

Lestes rectangularis. Black lake, Aug. 2; Beaver brook, Aug. 3; Stump pond, Aug. 3; Cairo, Aug. 29; Stony Clove near Hunter, Sep. 2.

Argia violacea. Jenkins' pond, July 29; Amber and White lakes, Aug. 2; Black lake, Aug. 2; Beaver brook and Stump pond, Aug. 3; Green lake, Aug. 28 (very abundant).

Argia translata. White lake, Aug. 2.

Amphiagrion saucium. Big pond, July 28 (with pruinose thorax, abdomen still red).

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[1] Those marked with an * are bred.

[2] Supplemental to the two lists by the same author referred to in the preceding pages, in N. Y. Ent. Soc. Jour. 1895, 3:39-48; and 1897, 5:91-96.

Ischnura verticalis. Folwood lake, July 22; Balsam lake, July 27; Alder lake, July 28; Big pond, July 28; Jenkins' and Burnt Hill ponds, July 29; Knapp, Hunter's and Mud ponds, July 30; Cranberry pond, July 31; Stevensville lake, Aug. 1; Amber, White and Black lakes, Aug. 2; Beaver brook and Stump pond, Aug. 3; Green lake, Aug. 28; Cairo, Aug. 29; Catskill lake, Aug. 30.

Enallagma hageni. Knapp pond, July 30 (not very abundant).

Enallagma aspersum. Burnt Hill pond, July 29; Knapp pond, July 30; Cranberry pond, July 31.

Enallagma exsulans. Port Jervis, July 21.

Enallagma geminatum. Amber lake, Aug. 2; Green lake, Aug. 28.

Enallagma ebrium. Balsam lake, July 27; Alder lake, July 28 (exceedingly abundant, many more males than females); Burnt Hill pond, July 29; Cranberry pond, July 31; Amber, White and Black lakes, Aug. 2; Beaver brook, Aug. 3; Catskill lake, Aug. 30.

Enallagma signatum. Folwood lake, July 22; Amber and Black lakes, Aug. 2; Stump pond, Aug. 3; Green lake, Aug. 28.

Enallagma pollutum. Black lake, Aug. 2.

Dromogomphus spinosus. White lake, Aug. 2.

Anax junius. Folwood lake, July 22; Alder lake, July 28; Burnt Hill pond, July 29 (abundant); Knapp, Hunter's and Mud ponds, July 30; Cranberry pond, July 31; Black lake, Aug. 2; Beaver brook and Stump pond, Aug. 3; Green lake, Aug. 28.

Cordulia shurtleffi. Near Tunis lake, July 27.

Dorocordulia lepida. Burnt Hill pond, July 29; Mud pond, July 30; Amber lake, Aug. 2.

Libellula pulchella. Folwood lake, July 22; Balsam lake, July 27; Alder lake and Big pond, July 28; Jenkins' and Burnt Hill ponds, July 29; Knapp and Hunter's ponds, July 30; Cranberry pond, July 31; Amber lake, Aug. 2 (only a few); Black lake, Aug. 2; Beaver brook and Stump pond, Aug. 3; Cairo, Aug. 29 (1 old ♂).

Libellula incesta. Amber lake, Aug. 2; Stump pond, Aug. 3.

Plathemis lydia (trimaculata). Beaver brook, Aug 3 (1 ♀ only); Cairo, Aug. 29 (1 old ♂).

Leucorhinia frigida. Knapp, Hunter's and Mud ponds, July 30; Cranberry pond, July 31 (abundant).

Leucorhinia intacta. Folwood lake, July 22 (1 ♀).

Celithemis elisa. Burnt Hill pond, July 29 (one only); Hunter's pond, July 30 (one only); Cranberry pond, July 31 (one only); Amber and White lakes, Aug. 2 (some in cop.).

Sympetrum rubicundulum. Folwood lake, July 22; Jenkins' pond, July 29; Knapp, Hunter's and Mud ponds, July 30; Black lake, Aug. 2; Stump pond, Aug. 3; Cairo, Aug. 29.

Sympetrum vicinum. Alder lake, July 28; Burnt Hill pond, July 29; Stevensville lake, Aug. 1 (just transforming); Amber lake, Aug. 2; Beaver brook and Stump pond, Aug. 3; Cairo, Aug. 29; Catskill lake, Aug. 30 (some transforming, others ovipositing).

Sympetrum semicinctum. Cairo, Aug. 29.

Aeschna constricta. Stony Clove, near Hunter, Sep. 2.

Localities

Records from Cairo, Catskill lake and Green lake were made in 1897. All others in 1898.

Big pond,	Andes "town" (=township),		Delaware co.
Balsam lake,	Hardenburg	"	Ulster co.
Tunis "	"	"	"
Alder "	"	"	"
Jenkins' pond,	Rockland	"	Sullivan co.
Burnt Hill "	"	"	"
Knapp "	"	"	"
Hunter's "	"	"	"
Mud "	Liberty	"	"
Cranberry "	"	"	"
Stevensville lake,	"	"	"
White "	Bethel	"	"
Amber "	"	"	"
Black "	"	"	"
Folwood "	Mamakating	"	"
Beaver brook,	Tusten	"	"
Stump pond,	"	"	"
Green lake,	Athens	"	Greene co.
Cairo,	Cairo	"	"
Catskill lake,	Hunter	"	"

Eastern Long Island species

COLLECTED AUG. 18, 1900

Lestes disjuncta. Bridgehampton
Enallagma doubledayi. Bridgehampton
Enallagma aspersum. Bridgehampton
Enallagma durum. Near Mecox bay (abundant; in cop.)
Enallagma civile. Near Mecox bay (abundant; in cop.)
Ischnura verticalis. Near Mecox bay and Bridgehampton
Anax junius. Near Mecox bay and Bridgehampton
Plathemis lydia (trimaculata). Bridgehampton
Libellula pulchella. Bridgehampton
Tramea carolina. Bridgehampton
Mesothemis simplicicollis. Bridgehampton

Near Mecox bay, where I found the two species of Enallagma above recorded were many individuals of the spider, Epeira stellata Hentz, whose orblike webs, 4 to 6 inches in diameter, were stretched between the stalks of sedges and of grasses. Within a distance of not more than $\frac{1}{10}$ mile along the pond's edge, I found six individuals of Enallagma in the spiders' webs. The dragon flies were all fully colored, were more or less enshrouded in silk, and some of them were partly eaten. In one and the same web were two Enallagmas.

Part 4

SOME NEW LIFE HISTORIES OF DIPTERA

BY JAMES G. NEEDHAM

During the second season of our station the work done on Diptera was chiefly done on the families Chironomidae, Culicidae, Simuliidae, and Blepharoceridae, and is reported on by Mr Johannsen in part 6. But, in the course of routine operations, a few other very interesting new forms were come on, and four of these will be described in the following pages. Two of these, Tipula flavicans and Epiphragma fascipennis, were bred, and two were found only in the larval stage. These larvae, however, are so unique and interesting as to warrant their description at once; one clearly

belongs to the family Tipulidae; the other to the family Leptidae.

Tipula flavicans Fabricius

1805 Tipula flavescens (*in erratis*, flavicans) Fabricius, Syst. Antliatorum, p.24
1821 Tipula flavicans Wiedemann, Diptera Exotica. 1:25
1828 Tipula flavicans Wiedemann, Aussereur. zweiflüg. Insecten, 1:48
1878 Tipula flavicans Osten Sacken, Cat. Dipt. N. Am. p.38 (listed)

This common crane fly is widely distributed over the eastern United States and Canada. It belongs to the New York fauna, but I bred it from pupae collected at Lake Forest Ill. The pupae were found in a peculiar and very restricted habitat. In the bottom of a glacial pothole on the top of a small moraine there was a deep bottom layer of mud, muck and humus, nearly dry from the summer's evaporation, and perforated by a few crawfish holes, around whose mouths were little hillocks of clay, brought up by the crawfishes from a deeper stratum. In these clay hillocks, and only in these, I found the pupae, placed vertically in cylindric cavities, their heads almost reaching the upper surface of the clay. I collected a number of the pupae on Sep. 22, and the imagos began to emerge on the 23d and were all out on the 27th. During this time the adult flies were common among the bushes all about the pothole. They were not so easy to catch as are most crane flies; they readily took flight on the approach of a net, and, if pursued, would take refuge high up in the branches of neighboring trees, well out of reach.

Pupa [pl.10, fig.3]. Length 26mm, abdomen 20mm, respiratory horns 1.3mm; greatest diameter of the thorax 4mm, of abdomen 3mm.

Body cylindric, tapering at ends on the head and from the eighth abdominal segment, the abdomen with parallel sides, the thorax thickened toward its middle. Colors (generally obscured by adherent dirt) brown, paler on wings and legs, on lateral margins of abdomen and on two broad dorsal and two ventral areas nearly covering each abdominal segment.

Head unarmed; rostral sheath and base of antennal sheaths transversely corrugated. Antennae curving posteriorly around

the eyes and ending at the middle of the thorax on its ventral side. Palpi ending in a J-shaped hook.

Respiratory horns cylindric, becoming laterally flattened at tip, erect but bent anteriorly in their distal third. Wings and legs closely covering the ventral surface; tips of the wing cases reaching the base of the fourth abdominal segment; legs much curved beneath the wing cases; tarsi laid straight along the ventral side of the abdomen, those of the fore legs reaching the constriction of the middle of the fourth, those of the middle and hind legs, the apical circlet of spines on the fourth abdominal segment. Thorax unarmed; a low carina between the respiratory horns, ending posteriorly in a series of transverse corrugations, on either side of which are spots and lines of darker color.

Abdominal segments transversely divided by a constriction, both before and behind which, dorsally and ventrally, is a broad pale area bordered by darker brown, forming at the sides a band which includes the row of spiracles at the anterior border of segments 1-7. In the pale band on the lateral margin there arises a stout spine in the basal half and a larger one in the apical half of segments 2-7; here are also numerous brown dashes, merging into the larger, phalerate markings already described.

On the dorsal side in the apical half of each of segments 1-7 there is a transverse row of about a dozen sharp, minute thorns, very minute on 2, but becoming larger posteriorly; on the ventral side of same is a similar row of stouter thorns, becoming much stouter and fewer and nearer the hind margin posteriorly, while before them, near the middle constriction, stand an isolated pair of similar size. On segment 8 there are three pairs of stout spines on the dorsum, the intermediate pair being the largest, and there are three lesser pairs on the venter. On the end of the abdomen, and perhaps belonging to a ninth segment, there are two other pairs of spines, a larger yellowish, brown tipped, straight pair, and a smaller, terminal, upcurved pair.

Epiphragma fascipennis Say

Plates 8, 9

Limnobia fascipennis Say, Acad. Nat. Sci. Phila. Proc. 3:19, 11:823

1828 Limnobia fascipennis Wiedemann, Aussereur. zweiflüg. Insecten, 1:31

1859 Epiphragma pavonina Osten Sacken, Acad. Nat. Sci. Phila. Proc. p.239

1869 Epiphragma fascipennis Osten Sacken, Mongr. N. Am. Dipt. 4:194

This beautiful crane fly [pl.8], which Osten Sacken attributes to the Atlantic states and Quebec, I have been trying to rear for several years at my home in Lake Forest; and I succeeded in the spring of 1901, and am now able to describe both larval and pupal stages.

The larvae bore in the dead and fallen stems of buttonbush and willow, where these lie on the mud at the borders of shallow ponds. I found them always in stems that were still partially sound, tunneling beneath the bark or even into the deeper parts and into the sounder wood. These stems are frequently submerged in spring and autumn, and even in summer, when the pond has gone dry, they are always saturated with moisture. The first two seasons that I tried to rear the larvae indoors I failed, because I could not keep their surroundings at the proper degree of moisture. In the spring of 1901 I placed the stems or pieces of the stems containing the larvae in the bottom of a big glass jar, hung a large sponge saturated with water in it, and laid on a loose cover, and with this apparatus I reared them, every one. Larvae and pupae were collected for rearing on May 18; imagos appeared on May 30. No imagos were seen at large, notwithstanding they were carefully looked for several times after they began to appear in the breeding jar.

The most interesting thing about the larva, aside from its wood-boring habits, is its singular adaptation to amphibian life. It must needs live part of the time wholly submerged beneath the waters of the pond, and part of the time out on land; it has, therefore, both open spiracles and tracheal gills; and, moreover, its tracheal gills are so placed that they may be withdrawn into the body in a dry time, where they escape the ills of too rapid evaporation. The spiracles are the two usual large ones on the terminal respiratory disk, common to all tipulidae. If a larva be taken from the stems and allowed to crawl on the hand, these will be the only respiratory apparatus visible; no fleshy anal processes, such as are common in the family, will be seen. The anal aperture will appear as a narrow longitudinal slit between two opercular flaps. But, if the same larva be

placed in a watch glass of water, these flaps will be seen to be separated, and there will be protruded between them four curved triangular, delicate, whitish, elongate gills, showing in their interior both tracheae and blood currents. These are doubtless respiratory appendages of the terminal portion of the walls of the rectum. A similar eversible condition of this part, with a much less perfect development of the gills themselves, has recently been described by Pantel in the *Bulletin de la Société entomologique de France*, 1901, page 59-61, for a Tachinid larva. The eversible portion of the rectum Pantel calls the anal vesicle, and to it he very properly attributes a respiratory function.

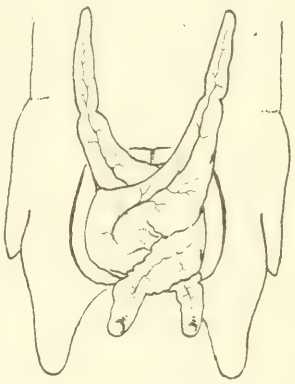

Fig. 18 Anal gills of the larva of Epiphragma fascipennis

These four gills in Epiphragma are comparable to the four anal processes of the larva next to be described, and shown on plate 10, fig. 4, even to the constriction forming an apparent segment near the tip. They are comparable and homologous doubtless with the anal processes of other Tipulidae. There, however, they are permanently on the outside of the body, being no longer retractile. The end of the rectum has become permanently everted in these more aquatic larvae. The larva of Epiphragma is therefore specially interesting as showing what has been the course of development of this part of the very curious caudal armature of the typical Tipulid larvae.[1]

Larva [pl.9, fig.1]. Length 19mm; greatest diameter (base of thorax) 1.5mm. Cylindric, white, or faintly tinged with yellowish, with translucent sides and a brown head capsule. Head large, for the family, with pale antennae and labrum and stout blackish mandibles and labium. On the ventral side of each of the three thoracic segments is a pair of minute brownish points—vestiges

[1] Elsewhere (*American Naturalist*, 36:185) I have pointed out, in a description of the larva of Bibio fraternus, that the segmental tubercles have offered the material out of which have been formed the other fleshy tubercles which surround the caudal respiratory disk.

of the larval legs. On the ventral side of abdominal segments 2-7 there is a single median proleg—a mere soft, white, transversely placed ridge, without hooks or claws. The abdomen is without other tubercles, spines or hairs. On the posterior end of the scarcely narrowed abdomen is a broad, white respiratory disk, with the two usual spiracles [pl.9, fig.2], large, distant, black, bordered with golden yellow in life. There are four thick processes at the border of the disk, of which the upper two are set apart the full width of the disk, have very blunt apexes and are pubescent externally, while the lower two are a little more pointed and a little closer together.

The anal aperture is closed by two operclelike plates, which open to allow the protrusion of the four delicate, white, elongate, curved, triangular anal processes (gills).

Pupa [pl.9, fig.3]. Length 12mm, horns almost 2mm additional; diameter 1.5mm. Color clear yellowish white at first, darkening with age, and showing before transformation the adult color pattern through the transparent skin; surfaces shining, nearly smooth. Head and face directed ventrally, with a pair of short, sharp pointed, stout, ventrally directed, divergent frontal spines.

The hypertrophied and functionless respiratory horns are large, long and stout, abruptly bent forward in their cylindric middle portion, beyond their short erect bases, and convergent at their tapering tips. They are very suggestive of cow horns in their shape, and a crumpled horn on one side is of rather common occurrence. The antennae curve dorsally around the eyes and knees and disappear beneath the wings. Legs laid flat against the ventral surface, the tips of the tarsi all ending near the apex of the fourth abdominal segment; wing tips reaching only to the level of the carina on the second abdominal segment.

Abdomen with sides parallel as far as the eighth segment; the apical carina on each segment is fringed with short, stiff hairs (on the ventral side of the eighth segment, more comblike, and interrupted on the median line in the female). The rudiments of the four discal processes and the atrophied spiracles are plainly seen on the dorsum of the eighth segment.

Beling found the larvae of the European Epiphragma picta abundant in the rotting stems of ash and beech in the spring, transforming in May after a pupal period of about two weeks. He has described[1] a very unusual sexual differentiation in the larvae. The respiratory disk was said to be surrounded by five processes arranged in a pentagon in the male, by three

[1]Beling. Th. zur Naturgeschichte verschiedener Arten der Tipuliden. Verh. zool.-bot. Ges. in Wien. 1873. 23:590.

processes arranged in a triangle in the female larva. There is no such differentiation in E. fascipennis; the processes are four, and alike in the two sexes. Possibly Beling had the larvae of two species.

An unknown Tipulid larva from a spring

On plate 10, figures 4 and 5 we present a figure of a Tipulid larva of very unusual form. A few specimens were obtained July 19, 1901, from a small, cold spring brook near Fall creek, between Ithaca and Varna N. Y. The brook was filled with water cress, through which the cold water trickled, and was hidden in the dense shadow of a thick growth of trees. The larvae were obtained only beneath the water cress, in the thin layer of soft mud overlying the rocky substratum. One larva was found, apparently preparing for transformation, occupying a little excavation among the roots of a layer of wet moss, in a crevice of a rock above the level of the water. This specimen was taken home for rearing, but was afterward lost; I do not know anything about the other stages of this insect. The form of its respiratory disk is very different from that of Epiphragma just described, but, aside from that, it is more like Epiphragma in form of body and prolegs and in mouth parts than any other Tipulid larva known to me, and I think it will be found to belong to some species of larger size belonging near Epiphragma in the series.

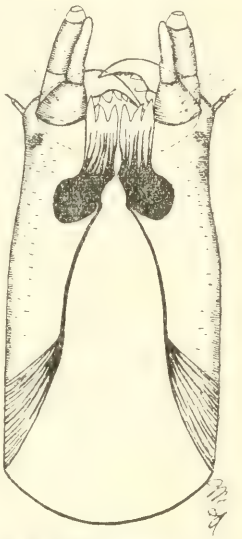

Fig. 19 Ventral aspect of head and mouth parts of unknown tipulid larva described herewith

Since my study of this larva Dr James Fletcher, of Ottawa Can., has sent me a specimen of it from his home. He says it is found "from time to time in water brought from a spring through wooden pipes, and used for drinking." It may prove a constant inhabitant of cold spring water.

Larva. Length 42mm; greatest diameter of thorax 5mm; of abdomen 7mm. Body cylindric, smooth, white translucent, with unusually abrupt narrowing at the anterior end to the wholly retractile head (fig.19). Seventh abdominal segment inflated. No surface hairs or spines; but on the ventral side of the three thoracic segments are three pairs of spine-tipped structures which I take to be the rudiments of the thoracic legs.

There are stout, brownish prolegs on abdominal segments 4-7, paired and separate on 4, becoming completely fused on succeeding segments into a transverse ridge, each proleg capped with a mere obtuse hillock of chitin, bearing no hooks or spines. Abdomen strongly tapering beyond the inflated seventh segment. Spiracles black, seated on a narrow and imperfect respiratory disk [pl.10, fig.5], whose dorsal margin is indicated only by a slight ridge, and from whose ventral side arise two long processes, approximated at base, tapering, slightly granulate before the tip, and with about six to eight minute, fragile, unequal hairs on the obtuse apex. Anal aperture surrounded by four equal, taper, pointed, white appendages, each showing a tendency to the formation of a telescopic joint at two thirds its length.

An unknown Leptid larva from rapid streams

On plate 10, figure 1 we show a curious larva that seems clearly to belong to the family Leptidae, but that differs considerably in structure from the Leptid larvae hitherto made known. I first collected small specimens from the rapids in Six Mile creek at Ithaca in December 1896. During the summer of 1901 larger larvae were frequently found in Fall creek. They live in the crevices of the stones in rushing waters, associated with stone fly and caddis fly larvae. But few specimens were obtained, and no attempt was made to rear them. Two species of Chrysopila, (C. o r n a t a and C. t h o r a c i c a), are common at Ithaca, and this larva may belong to one of these.

Larva. Length 16mm; caudal filaments (arising from the ventral border of the respiratory disk) 3mm additional; diameter 2mm.

Color dark greenish; skin subrugose, somewhat shining. Body nearly cylindric, slightly thickest on the sixth abdominal segment, with strongly tapering metathorax and mesothorax, slender and attenuate prothorax and strongly retractile head. The median ridge of the head is very prominent in front, shaped like an inverted sled runner. Antennae prominent, slender, two jointed. Mandibles ending in strong, ventrally directed

hooks. A ventral pair of slender bristles under both mesothorax and metathorax.

There are stout ventral prolegs on abdominal segments 1-8, paired on all the segments except the eighth, each with a double circlet of hooks at its tip. On segment 1 each proleg is simple, with hooks directed posteriorly. On segments 2-7 each proleg is divided at its apex, becoming double, with the hooks on its two divisions opposed in position [pl.10, fig.2]. On the eighth segment there is a single median proleg with its hooks directed forward, and at its base is a pair of low, broad anal tubercles. There are two pairs of conic, fleshy tubercles on each of segments 1-7 of the abdomen, one tubercle at either side of the dorsum and a longer one at the middle of each side, all increasing in length posteriorly. The abdomen ends on the dorsal side in a pair of long, fleshy processes, stout at base and attenuate to apex, each with a lateral fringe of long hairs each side, on the outer side the fringe extending on segment 8 nearly to its base. Between the bases of these processes on the dorsum of the eighth segment is the single respiratory aperture—a narrow median slit guarded by white lips, on a low convex elevation.

The most remarkable features of this larva are (1) the conformation of the caudal end of the abdomen, (2) the single respiratory aperture and (3) the paired and bifurcated prolegs with their heavy armature of grappling hooks. This grappling apparatus is doubtless correlated with a life spent clinging to the surfaces of rocks in the current of rushing streams.

A note on caddis flies described in Bulletin 47

The identity of the species described on p.569-70 as "3 Halesus sp. ?" has been settled by the rearing of it by Mr Betten at Lake Forest Ill. It is Halesus hostis Hagen. Larvae, in cases like the one shown in plate 33, figure 1 of Bulletin 47, were collected from a spring-fed rivulet late in August. Pupae were found in the breeding cage soon thereafter, and a fine male imago emerged on Sep. 23.

Two excellent German students of the Trichoptera, Ulmer and Weltner, simultaneously and very kindly sent information as to the probable identity of the "egg-ring of an unknown caddis fly" figured on plate 33 of Bulletin 47. Similar egg masses are laid, they say, by the European species Phryganea grandis and Phryganea striata, and this one may well have belonged to our Phryganea cinerea Hagen.

Part 5[1]

AQUATIC CHRYSOMELIDAE

AND A TABLE OF THE

FAMILIES OF COLEOPTEROUS LARVAE

BY ALEX. D. MACGILLIVRAY

Beetles are among the most abundant of insects. They are easily collected and prepared for the cabinet and probably for this reason are more extensively studied and collected than any other order. Their larvae and pupae are usually soft bodied and inconspicuous and in most cases are very difficult to rear to maturity. It is probably due to these latter conditions that the transformations of only a very small proportion of our beetles are known. The habits of their larvae are more varied than those of the other orders; some are predaceous, feeding on the larvae of other insects; some are scavengers, feeding on decaying plants and animals, dried skins, hair and bones; some are herbivorous, feeding on the roots, stems and leaves of plants, mining their leaves, living within their seeds, forming galls on their leaves, or tunneling through the trunks of trees; some feed on and destroy many kinds of prepared food products, while others live commensally within the nests of insects. Though the majority of the species are terrestrial, yet many are found on the surface and within the water of ponds and streams.

There have not been any extended investigations dealing with the transformations of American Coleoptera. The work done thus far consists mainly of scattered descriptions by government and state entomologists in bulletins, reports and entomological magazines, and they have dealt in great part only with those species that are of economic importance in some phase of their life history.

The most important publications for the student of the life histories of American Coleoptera are the following:

Beutenmüller, William. Bibliographical Catalogue of the Described Transformations of North American Coleoptera. N. Y. Micro. Soc. Jour. VII, 1891. 7:1-52.

This paper gives all the references to descriptions and figures of American beetle larvae and pupae previous to this date and should be in the hands of every American student of this subject.

[1]Not edited according to the rules of the University.

Rupertsberger, Mathias. Biologie der Käfer Europas. Eine Uebersicht der biologischen Literatur gegeben in einem alphabetischen Personen- und systematischen Sach-Register nebst einem Larven-Cataloge. Linz a. d. Donau. 1880. O. 295p.

———— Die biologische Literatur über die Käfer Europas von 1880 an. Mit Nachträgen aus früherer Zeit und einem Larven-Cataloge. Linz a. d. Donau und Niederrana. 1894. O. 310p.

The two papers given above include the references to the literature on the transformations of European Coleoptera. They are useful to the American student for the references to the species common to Europe and North America that they contain. The larger families of Coleoptera are found in both countries, and, by looking up these references, it is possible to determine the type of larvae to be expected in the American fauna in those families where they are unknown.

Schiodte, J. C. De Metamorphosi Eleutheratorum observationes: Bidrag til insekternes udeldviklingshistoire. Kjobenhaven. 1861-83. 2v. O. 86pl.

Each volume is made up of a number of separate parts which were originally published separately in the *Saertryk af Naturhistorisk Tidsskrift*. Though this work deals entirely with European insects, yet the families and genera in most cases are found in this country. The text is written in Latin, the descriptions are very full and suggestive. The figures are excellent; they are printed from copper plates and show the entire form of the larva and pupa, together with many useful structural details.

Perris, Edouard. Larves de Coleopteres. Paris 1887. gr. O. 590p. 14pl. with 579fig.

This work consists mainly of descriptions of larvae and pupae, and the figures deal almost entirely with structural details.

In hope of interesting and aiding others in the study of the transformations of the Coleoptera, the following table has been prepared. It is based in great part on the facts contained in the papers mentioned above and deals only with the more important families. No one can be more conscious of its imperfections than the writer; but a poor tool is better than no tool.

KEY TO FAMILIES OF COLEOPTEROUS LARVAE[1]

a Tarsi with two claws

b Mandibles of the usual type, with teeth at the base or at middle

c Abdomen not provided with long, slender lateral filaments

d Cerci present, in some cases small; ocelli six

e Abdomen and legs ambulatory; abdomen with eight pairs of spiracles ..... Carabidae

ee Abdomen and legs natatory; abdomen with seven pairs of spiracles ..... Amphizoidae

dd Cerci wanting; ocelli four; with hooks on the dorsum Cicindelidae

cc Abdomen provided with long, slender lateral filaments which serve as tracheal gills..... Gyrinidae

[1] In the following table the term setae is applied only to those small hairs that arise from a single hypodermal cell like those of the Dermestidae, Cerambycidae, and Buprestidae; and the term spine is restricted to the strongly chitinized hairs that are developed as projections of the body wall, like those of the Coccinellidae and the Cassidinae of the Chrysomelidae.

bb Mandibles suctorial, without teeth at middle or at base
c Apex of the abdomen not armed with four hooks...Dytiscidae
cc Apex of the abdomen armed with four hooks.....Gyrinidae
aa Tarsi never with more than a single claw; in some species the legs entirely wanting
b Cerci present as jointed appendages, in some cases hardly more than a jointed tubercle
c Larvae long, wirewormlike; the caudal end of the abdomen strongly chitinized; larvae terrestrial.....Elateridae
cc Larvae soft bodied, not wirewormlike; the caudal end of the abdomen not more strongly chitinized than the remainder of the body
d Eyes in groups of five or six
e Larvae terrestrial, feeding in fungi.....Scaphidiidae
ee Larvae aquatic
f Eyes in groups of five.....Haliplidae
ff Eyes in groups of six.....Hydrophilidae
dd Eyes in groups of four, two, or none; larvae terrestrial
e Labrum present, distinct; body frequently lepismoid in form Silphidae
ee Labrum wanting; body not lepismoid in form, the sides subparallel
f Eyes present, usually in groups of four..Staphylinidae
ff Eyes wanting.....Histeridae
bb Cerci wanting
c Larvae without thoracic legs
d Head broader than the remainder of the body; the body depressed; larvae wood borers
e Maxillary palpi with three or four segments; the labial palpi with three segments; eyes frequently present Cerambycidae
ee Maxillary palpi with two segments; the labial palpi minute, unsegmented; eyes usually wanting.....Buprestidae
dd Head not broader than if as broad as the remainder of the body; the body cylindrical; the larvae infesting seeds..Bruchidae
cc Larvae with distinct thoracic legs
d Larvae scarabaeoid, that is, white grub-like, in form
e Eyes present
f Eyes six in number; larvae case-bearers Chrysomelidae
ff Eyes two in number; larvae not case-bearers Trox Scarabaeidae
ee Eyes wanting, or if present, usually of not more than a single ocellus
f Antennae three jointed, minute, hardly projecting beyond the side of the head; larvae usually small.....Ptinidae
ff Antennae two to six jointed, never minute, usually as long as, or longer than, the mandibles; larvae usually large Lucanidae Scarabaeidae
dd Larvae not scarabaeoid in form
e Apex of the abdomen not more strongly chitinized than the remainder nor produced into one or two prominent projections

f Body densely covered with long, fine setae which are generally barbed and frequently aggregated into a pencil at the posterior end of the body.....Dermestidae

ff Body not densely covered with long, fine setae, or, if present, these are minute and never aggregated in the form of a pencil at the posterior end of the body. No account is taken here of the strong black or brownish chitinized spines

g Larvae aquatic

h Antennae as long as, or longer than, the thorax Dascyllidae

hh Antennae not as long as the thorax

i Larvae depressed, with the lateral margins of the segments greatly produced so as to conceal the ventral and lateral portions of the body when viewed from above; with tracheal gills on the abdomen Parnidae

ii Larvae cylindrical; without tracheal gills

j Labrum wanting: each body segment usually with four long, filiform appendages; eight abdominal tergum never with a pair of dorsal spines with spiracles at their base.....Haliplidae

jj Labrum present; none of the body segments with long, filiform appendages; eighth abdominal tergum with a pair of dorsal spines with spiracles at their base; larvae feeding on the roots of aquatic plants .....Chrysomelidae

gg Larvae not aquatic

h The lateral margins of the abdominal tergites dilated so as to conceal the plurae when viewed from above, the dilatations when elongate, narrowed toward the apex

i Body convex, about twice as long as wide; lateral dilatations blunt and covered with numerous minute setae .....Endomychidae

ii Body flattened above, distinctly more than twice as long as wide; the lateral dilatations frequently pointed and never covered with numerous minute setae .....Lampyridae

hh The lateral margins of the abdominal tergites not dilated so as to conceal the plurae when viewed from above

i Body covered with strong, elongate, black or brownish, chitinized spines

j Median pair of spines of the eighth abdominal tergite long and modified into a faeci-fork for carrying the cast larval skins and faeci, umbrellalike over the back.....Chrysomelidae

jj Median pair of spines of the eighth abdominal tergite not longer than the others, and, if any are elongate, it is the median pair of the ninth abdominal tergite

k Median pair of spines of the ninth abdominal tergite distinctly longer than any of the other tergal spines ..... Erotylidae

kk Median pair of spines of the ninth abdominal tergite not longer, all the tergal spines subequal in length ..... Coccinellidae

ii Body sometimes covered with fine, translucent setae but never with elongate black or brownish chitinized spines

j Body covered with fine clavate setae

k Ninth abdominal tergum with a pair of short, stout, chitinized spines..... Erotylidae

kk Ninth abdominal tergum not with a pair of stout chitinized spines..... Endomychidae

jj Body not covered with clavate setae

k Body completely covered with a white flocculent mass; larvae aphidivorous... Coccinellidae

kk Body never covered with a white flocculent mass

l Larvae provided with abdominal prolegs on at least one abdominal segment Chrysomelidae

ll Larvae not provided with abdominal prolegs

m Thorax abruptly broader than the head and abdomen; living in burrows of mud or sand in wet places..... Heteroceridae

mm Thorax not distinctly broader than the abdomen, if broader, only gradually so and then only the prothorax markedly so

n Tergum or sternum or both with distinct chitinized areas, frequently prominent, proleglike

o Body usually depressed; the distance between the prothoracic legs greater than the length of the legs Cerambycidae

oo Body usually cylindrical; the distance between the prothoracic legs not as great as the length of the legs Oedemeridae

nn Tergum or sternum never with distinct chitinized areas

o Ninth abdominal tergite with two or more short cuticular spines

p Apex of the abdomen obliquely truncate; antennae[1] with three segments Cioidae

[1] In counting the segments of the antennae, it is frequently difficult to determine whether the enlarged globular basal portion should be counted as a segment or not. Some writers have considered it simply as a protuberance of the head, while others have looked on it as the first antennal segment. In this table it is considered as a distinct segment.

pp Apex of the abdomen not obliquely truncate; antennae with four segments .....Nitidulidae

oo Ninth abdominal tergite not with short cuticular spines

p Antennae consisting of four segments

q Labrum distinctly present

Nitidulidae
Cucujidae

qq Labrum wanting.....Elateridae

pp Antennae consisting of three segments

q Labrum wanting....Lampyridae

qq Labrum distinctly present

Melandryidae

ee Apex of the abdomen strongly chitinized and usually produced into one or more prominent projections

f Entire abdomen strongly chitinized and cylindrical, the apex squarely truncate and not produced into projections

Rhipiceridae

ff Entire abdomen not strongly chitinized and, if so, never truncate at the apex; flattened or cylindrical, and the apex always produced into one or more prominent projections

g Antennae consisting of four segments

h Abdomen strongly chitinized only around the bases of the chitinous projections of the apex of the tergum; usually somewhat flattened

i Last abdominal segment produced into two strongly chitinized and bifurcating processes

j Abdomen strongly depressed..Pyrochroidae

jj Abdomen cylindrical or subcylindrical, not strongly depressed

k Bifurcating process of the last abdominal segment with lateral spines or tubercles

Trogositidae

kk Bifurcating process of the last abdominal segment not with lateral spines or tubercles

Colydiidae
Mycetophagidae
Malachidae
Cleridae
Melandryidae

ii Last abdominal segment produced into a single strongly chitinized process, which is usually slightly angularly emarginate at apex.....Mordellidae

hh Abdomen strongly and evenly chitinized throughout, cylindrical or subcylindrical

i Labrum wanting.....Elateridae

ii Labrum present and separated from the clypeus by a distinct suture.....Tenebrionidae

gg Antennae consisting of three segments
h Abdomen cylindrical, obliquely truncate at apex, the chitinized apical projection on the dorsal aspect and projecting dorsad.....Cioidae
hh Abdomen subcylindrical, not obliquely truncate at apex, and the chitinized apical projection at apex and subhorizontal .....Lagriidae

Family CHRYSOMELIDAE

This family includes about 600 species divided into 11 subfamilies. The larvae feed on the leaves of various plants. Two of the subfamilies contain species that feed on aquatic plants. These can be separated as follows:

Larvae

Dorsal surface of the eighth abdominal segment with a pair of pointed spines; abdominal prolegs wanting..... Donaciinae
Dorsal surface of the eighth abdominal segment not with a pair of long spines; abdominal prolegs present.....Galerucinae

Pupae

Pupae inclosed in a tough brownish silken cocoon, not attached, and whitish in color..... Donaciinae
Pupae naked, attached to the leaf surface by the apex of the abdomen, and blackish in color.....Galerucinae

Imagos

Prothorax not with a thin lateral margin..... Donaciinae
Prothorax with a distinct thin lateral margin.....Galerucinae

Subfamily DONACIINAE

In our fauna this subfamily includes two genera, Donacia with 20 species and Haemonia with a single species. All the species are similar in habit, the larvae feeding on the submerged underground stems of aquatic plants. They have been collected on Nymphaea advena, Sparganium androcladium, Sagittaria latifolia, Sagittaria rigida, and Potamogeton.

It is a well known fact that in all insects that live submerged in water there are special modifications in structure to fit them for such a mode of life. They are either provided with special organs for taking their supply of oxygen from the air mixed with the water, as tracheal gills, or they are so modified that

they can carry a supply of air with them. Many water beetles carry a supply of air under their elytra; others carry it on the ventral side of the abdomen and thorax. This supply is replenished and purified by the insect going to the surface of the pond from time to time. By the larvae, pupae, and adults of the Donaciinae, neither of the above methods is in use. In the following pages the method these insects pursue for obtaining a supply of air will be described. The account is based on studies made on the life history of Donacia palmata, which occurs abundantly throughout the summer at Ithaca.

Specimens of Donacia palmata were found most plentiful on the plants of the yellow pond lilies growing in the lagoon extending from the south side of Fall creek just above where it empties into Cayuga lake. It is known as the White Lily pond, because it is the only place where this plant is found at the head of the lake. This lagoon extends off from the main stream in a rather sinuous course for about 200 yards. At no place is the water more than 3 feet deep. The bottom consists of soft loamy ooze about 2 feet deep. It is in this ooze that the underground stems of the yellow pond lily grow. In order to obtain the stems containing larvae, it was necessary to get into the water and pull them up from the bottom of the ooze. Along the banks of the lagoon there was a luxuriant growth of Sagittaria, Pontederia, Polygonum sagittatum, Scirpus, and Typha. It was along here that the larvae and pupae of Donacia aequalis and Haemonia nigricornis were obtained. The conditions existing are well shown by plate 20, where the luxuriant shore growth is represented in the foreground, while the water just beyond is almost hidden by the leaves of the yellow pond lilies floating on its surface.

In the early summer, while the water is deep or the stems are not long enough to raise their leaves above the surface of the water, the eggs are laid on the underside of the leaves of the large yellow pond lily, Nymphaea advena. Growing in

this same lagoon there were a number of plants of the white pond lily, Castalia odorata, and as soon as the leaves of Nymphaea were raised above the surface of the water the eggs were deposited on the leaves of this plant [pl. 21, fig. 1]. In June and early in July the beetles were abundant, flitting about on the upper surface of the leaves. As the female beetle apparently can not live submerged in water, she has adopted the ingenious plan of cutting a hole, round or oval, about ¼ inch in diameter in the leaf from the upper surface. She then inserts her long extensile abdomen [pl.30, figs.4-5] through the hole and lays her eggs in a circle on the underside [pl.21, fig.4]. Each mass consists of a double row of eggs, which are fastened together and to the surface of the leaf by an opaque gelatinous substance, which completely covers the eggs [pl.21, fig.4]. The eggs are elongate, the sides are parallel, and each end is obtusely rounded. The chorion is smooth, without surface sculpture and opaque white in color. The beetles do not emerge in definite broods, so that eggs in all stages of development can usually be collected at almost any time during the summer and fall.

The other species of Donacia differ from palmata in the manner and place of laying their eggs. The eggs of cinecticornis, whose larvae are also found on the roots of Nymphaea, are laid in a compact mass on the stems of a sedge [pl.21, fig.3], while those of porosicollis are laid in a row along the edge of a leaf sheath of the species of sedge on which the larvae feed [pl.21, fig.2].

The eggs hatch in about 10 days, and the young larvae find their way to the bottom of the pond and among the ooze and attach themselves to the underground stems of the yellow pond lily. Numerous underground stems of the white pond lily were examined, and not a single one was found with the larvae of Donacia attached to it, or with any indications of where larvae had been feeding on it, though in most cases the stems of the two species of plants were intertwined. It is certainly marvelous

that these delicate larvae are able to locate themselves in this way, and many of them must fall prey to fishes in their transit.

The larvae just emerged from the egg have all the general characteristics of the mature larvae, with the addition of many long, stiff hairs [pl.27, fig.13]. These hairs are very similar to those found on recently hatched butterfly larvae, as they have been figured by Dr S. H. Scudder.[1] In specimens kept in aquaria it was found that these hairs were soon shed. It has not been possible to determine anything as to their function, though they may have to do with freeing the larva from the eggshell or they may be for entangling a supply of air to be used by the larva till it finds some of the roots of Nymphaea, though this certainly can not be the reason for their occurrence in the larvae of the butterflies.

With such conditions as those under which this study was made it was neither practicable nor possible to follow the larva from the time it left the egg till it began feeding on the roots of Nymphaea. In this pond there was only one species of Donacia larvae found in great abundance feeding on the underground stems of Nymphaea, there was only one species of adult found abundantly on the leaves of the plant, and in both cases this was p a l m a t a . There was only a single kind of egg found abundantly that produced Donacia larvae, and this, together with the above circumstances, certainly warrants the conclusion that these were the eggs of D o n a c i a p a l m a t a .

When the large underground stems were examined, they were usually found covered with larvae of various sizes and with cocoons [pl.22]. The larvae were found clinging to the larger roots and feeding on the fine rootlets with which the roots are covered. Several roots are shown that appear to be covered with minute tubercles [pl.22*r*]. These tubercles are the places from which the rootlets have been cut off by the larvae. In addition to the above, the larvae also eat holes in the apices of the larger roots. A larva feeding in this way is shown on plate 27, figure 18, where the head, prothorax, and mesothorax

[1]Scudder, S. H. Butterflies of the Eastern United States. v.3, p.70-73.

are imbedded in the tissue of the plant. Scars showing where other larvae have been feeding are represented at *e* and on plate 28, figure 1*e*. Several nearly mature larvae are shown on plate 22*z* attached to the underground stems. As the stem elongates, new leaf stalks are formed at the growing end. The bases of two of these are shown on plate 22*x*. Just back of these will be noted a number of rough, pitted, ovate areas [pl.22*y*], the leaf scars, the places where leaf stalks were formerly attached. On many of these scars will be seen ovate, cylindrical bodies [pl.22*o*], which are the cocoons. The cocoons are spun by the larvae from silk secreted by glands that open in the mouth. When the cocoons are opened, larvae, prepupae, pupae, just transformed adults, or mature adults may be found at the same time. On plate 22*a* are shown three cocoons from which adults have emerged.

The larvae are opaque white or slightly yellowish in color and scarabaeoid in form. The head [pl.28, fig.1] is minute and frequently almost concealed by the pronotum. The eyes are present in palmata, though they are apparently wanting in some other species. The labrum [pl.25, fig.6] is minute and usually four sided; projecting from its distal margin are a number of setae, the marginal setae [fig.6*mg*] which are attached to its ental surface; its disk bears six long setae arranged in pairs, a distal pair [fig.6*ds*], a median pair [fig.6*md*] and a proximal pair [fig.6*px*]; laterad of the discal setae there is on either side a single long lateral seta [fig.6*ls*], and near the discal setae there are one or two pairs of pitlike openings, the sensory spots [fig.6*sn*]. The thoracic segments are rotund, with six short, hooked legs. The abdomen is composed of 10 segments, seven of which are well developed, but the last three are minute and curved beneath the sixth and seventh.

There seems to be considerable disagreement as to the number of segments that are present. Perris[1] considers all that portion beyond the seventh [pl.27, fig. 17 and 19] as one segment, Heeger that it is made up of two segments, while Schmidt-Schwedt[2] and Sanderson[3] consider this portion to be made up

[1]Perris, E. Histoire des Metamorphoses de la Donacia sagittariae. Ann. Soc. Ent. Fr. (2) 1848. 6:33-48, pl.2, no. 2.

[2]Schmidt-Schwedt, E. Noch einmal über der Athmung der Larven von Donacia crassipes. Berl. Ent. Zeit. 1889. 33:299.

[3]Sanderson, E. D. The larvae of Donacia piscatrix Lac., and crassipes Fab. Can. Ent. 1900. 32:252.

of three segments, an eighth, ninth, and a minute tenth. When the dorsal aspect of the segments in front of this region is studied, they are found to be divided transversely into two subsegments, each subsegment bearing a transverse band of setae. If we compare this with the region behind the seventh segment, we find that there are four indistinctly marked transverse divisions, each bearing a band of setae, which would seem to indicate that we have to do with two segments. But, when the ventral aspect is studied, we find that the transverse divisions separating the segments into subsegments are wanting, and that each transverse line marks the suture between two segments, and, when the portion beyond the seventh segment is examined, there are found two transverse divisions [pl.27, figs. 17 and 19], which proves conclusively that this portion is made up of three segments, making 10 abdominal segments in all. The first transverse division on the dorsal aspect caudad of the seventh segment is the suture dividing the eighth segment into subsegments; the ninth and 10th segments are not divided into subsegments. These conclusions are apparently refuted by plate 28, figure 17, where only a single ventral division is shown beyond the suture of the seventh segment, but a few sections on either side of the one from which this figure was made show two well marked ventral divisions.[1]

Each segment bears a number of minute hair-like setae. The arrangement of these setae into definite areas and the interrelation of the areas seem to furnish the best characters for separating the larvae of the various species. It has been found necessary for the sake of exactness and brevity to apply names to these areas [pl.30, fig.1] which are as follows:

The tergal setae are the double row of transverse setae on the dorsum of each segment, the anterior row being known as the anterior tergal setae [fig.1*at*] and the posterior row as the posterior tergal setae [fig.1*pt*].

The supraspiracular setae are the patches of setae between the spiracles and the tergal setae [fig.1*ss*].

The infraspiracular setae are the small patches of setae immediately beneath the spiracles [fig.1*is*].

The pedal setae are the patches of setae surrounding the thoracic legs and on the protuberances where the prolegs would be situated if they were present [fig.1*ps*].

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[1] "The long filiform lateral appendages" referred to by Mr Sanderson as figured by Kolliker, A. Observationes de prima insectorum genesi adjecta articulatorum evolutionis cum vertebratorum comparatione. Observationes de prima insectorum genesi. Ann. des Sci. Nat. (2) 1843. 20:267-99, pl.12, fig.6, are the deciduous setae represented on pl.27, fig.13; and I can not see how they can have any bearing on the question of the homology of the segments.

The sternal setae are the patches of setae on the ventral side of each segment between the patches of pedal setae of either side [fig.1*st*]. The sternal setae of the thoracic segments are frequently divided transversely into two groups: the anterior group may be known as the anterior sternal setae [fig.1*ast*] and the posterior group as the posterior sternal setae [fig.1*pst*].

In the figures representing the setae of the thorax and abdomen, the plan originally devised by Dr Friedrich Brauer for showing the setae occurring on the larvae of the Oestridae or bot-flies has been followed. By this method each segment is represented as a parallelogram and the topographic arrangement of the setae indicated by dots.

There are nine pairs of spiracles present; one pair is situated on the cephalic margin of the mesothorax and eight pairs on the first eight abdominal segments. The spiracles on the first seven abdominal segments are small and, so far as is determinable from their histological structure, are functional. The first abdominal spiracle is on the lateral aspect of the body, but the succeeding pairs gradually converge toward each other till the eighth abdominal segment is reached, which contains a pair of large active spiracles, opening on the dorsal surface, one on either side of the meson.

Associated with the spiracles of the eighth abdominal segment, there are a number of well marked sclerites. The largest and most prominent is a thick and well chitinized peritreme which completely surrounds the spiracular opening except in front at middle, where there is a very evident interruption [pl.27, fig.19*p*]. Cephalad and laterad of the peritreme there is a prominent sclerite, the anterior sclerite, which is of about the same size as the peritreme and distinctly separated from it by a well marked furrow [fig.19*as*]. This sclerite varies slightly in position and extent in different specimens. In some cases its mesal end is interpolated between the peritreme and the caudal end of the apodeme and in such cases usually contains a prominent, lateral, tongue-like projection. Projecting cephalad from each cephalo-mesal angle of the sclerite just described, there is a long thread-like sclerite, which is one of the chitinized sides of a large dorsal apodeme which is invaginated just in front of and between the anterior sclerites. This apodeme, together with the anterior sclerites, serves for the attachment of a complicated system of muscles which are used in moving the caudal spines. Plate 27, figure 14, represents a longitudinal section of this apodeme, showing the attachment of 11 distinct groups of muscles. The opening of this apodeme was mistaken by Mr Sanderson for the opening of the rectum. On plate 28, figure 17*al*, is represented a median longitudinal

section of the alimentary canal of the three apical abdominal segments, where the position of the rectum is shown at *rec* and the position of the apodeme at *da*.

Projecting from the caudal margin of each peritreme is a long pointed spine which extends from the eighth abdominal segment to or near the apex of the abdomen [pl.27, figs.18-19*cs*]. These are the caudal spines. On plate 28, figure 2, a lateral view of one of these spines is shown enlarged, together with its connection with the peritreme, *pc*, the cuticular pocket into which the spiracle of the eighth abdominal segment opens, *cp*, and the outer end of the dorsal apodeme, *da*. Figure 3 represents the apex of a spine still more enlarged, so as to show the teeth on its ventral side. If a spine is examined in cross section near the middle of its length [pl.28, fig.2*d-e*], it will be found that it is ovate in outline [pl.28, fig.4], the dorsal surface evenly convex, the sides somewhat flattened, and the ventral surface produced into a prominent angle. The cuticle of the dorsal and lateral surfaces is thick and strongly chitinized, while on the ventral surface the cuticle is thin, soft, and hardly chitinized at all. This is more marked at the base of the spines and is evidently to allow for a freer dorso-ventral motion. The interior of the spine at this point contains 10 cavities, which may be divided into two classes, those containing hypodermal cells and those that are empty. Those of the first class are the largest and most important and will be considered first. Beginning at the ventral side, the angular portion is filled by a large ovate shaped cavity which has a tongue-like projection extending four fifths the length of the section [fig.4*vc*]; on either side of this tongue-like projection is a large cavity, which is ovate in outline, its mesal sides straight, and with a large tooth-like projection extending into its dorso-lateral portion [fig.4*pvc*]. Dorsad of each of the cavities just described there is another much smaller cavity, which is almost round in outline [fig.4*pdc*] and dorsad and mesad of each of these, there is a single minute cavity which is completely filled with cells. The three ventral hypodermal cavities [fig. 4*vc* and 4*pvc*] are continuous with the cavity at the base of the spines, the three dorsal hypodermal cavities [fig. 4*dc* and 4*pdc*] are cross sections of pockets that have probably been formed from infoldings from the dorsal tongue-like portion of the ventral cavity. The cavities of the second class are minute, four in number [fig.4*cc*], a pair laterad and another pair dorsad of the dorsal pair of hypodermal cavities.

If another section is examined near the body at the point *f-g* indicated on plate 28, figure 2, it will be found that the three ventral cavities are much larger [pl.28, fig.5], that the three

dorsal cavities have entirely disappeared, and that the cuticle, while of about the same thickness, is not so strongly chitinized except around the periphery of the spine and the periphery of the ventral pair of cavities [pl.28, fig.5*pc*]. Then, if a section is taken at the point *h-i* [pl.28, figs. 2 and 8], it will be noted that the cuticular wall of the ventral side of the spine [pl.28, fig.6] is continuous with the body wall of the eighth abdominal segment, and that the ventral cavity is merged into the cavity at the base of the spine, while the ventral pair of cavities have moved nearer the dorsal surface of the spine, and the portion represented in figures 4 and 5, *pvc*, as filled with hypodermal cells is at this point filled with cuticle, which completely fills the cavity. Figure 17 of plate 28 represents a sagittal section through the apex of the abdomen and through one of the caudal spines, *cs*, the section passing mesad of the spiracular opening. At the base of the spine should be noted the cuticular pocket, *cp*, which extends into the paired ventral cavities at the base of the spine, and the thick layer of hypodermal cells, *hcp*, surrounding the cuticular pocket. The base of the spine and its related portions are shown at figure 8 still more enlarged. The section from which this figure was drawn was taken laterad of the spiracular opening. In this figure should be noted likewise the paired ventral cavities, *pvc*, the ventral cavity, *vc*, and the cuticular pocket, *cp*. It shows also the intimate relation existing between the paired ventral cavities and the cuticular pocket, the cuticular wall of the pocket extending into the bases of the cavities like a wedge and completely closing them, as was described above [pl.28, fig.8*w*]. Figure 11 is a cross section taken at about the point *j k* of figure 8 and shows the pair of marked cuticular thickenings which form the proximal ends or bases of the paired ventral cavities, *pvc*, the large cavity contained between and around the cuticular thickenings, and the caudal part of the spiracular opening, which in this section does not communicate with the exterior. The spiracle opens directly at the base of the spine [pl.27, fig.19*s*] and extends from the surface in a cephalo-ventral direction into the cuticular pocket. On plate 28, figure 10, is shown a section cephalad of the one just described, which shows the external communication of the spiracle and the heart-shaped cuticular mass which forms the cuticular pocket, the heart-shaped form being derived by the gradual extension of the cuticle into the cavity lying between the cuticular thickenings forming the bases of the paired ventral cavities. Figure 13 represents a section taken at about the level *l-m* of figure 8. It is located cephalad of the spiracular opening and shows how the air passage, *os*, extends cephalo-ventrad into the interior of the cuticular pocket.

Figure 9 is still further cephalad and is taken at about the level *n-o* of figure 8, and shows the cuticular pocket entirely separated from the body wall and the thick cuticular wall inclosing the air passage on the dorsal side and its almost complete thinning out on the ventral side to allow for the entrance of the trachea. Figure 12 represents the air passage as crowded still farther on to the ventral side by the thick chitinous walls, while figure 7 shows the solid cephalic end of the cuticular pocket and the tracheal trunk almost completely separated from it, with three thick bands of muscles near the ventral end of the trachea which extend to the dorsal apodeme and the body wall and are effective in holding the trachea in place.

The trachea from each spiracle extends cephalad and mesad for a short distance, where they are united by a short transverse tracheal trunk [pl.28, fig.14*ttr*]. From their dorsal and mesal angle extend pronounced cuticular thickenings, from which muscles extend to the dorsal apodeme, *da*, and other muscles in turn extend from the apodeme to the body wall. From the common union just described there extends on either side as far as the head a single tracheal trunk, which is ovate in outline in transection, the long diameter being seven or eight times the short diameter, while the taenidia are long and greatly thickened and are arranged like a series of parallel rods along each face of the trachea. This arrangement of the taenidia and shape of the trachea permit its being expanded and used as a reservoir for storing the air between air-taking periods. The taenidia are shown in transection on plate 27, figure 15*t*, which is a section across the short diameter of the trachea, and in surface section by figure 16*t*. The tracheal trunks extending from the large lateral trunks to the spiracles of the other segments are of the ordinary type, cylindrical and with fine spiral taenidia.

The cuticle forming the cuticular pocket consists of long, fine and closely appressed plates or lamellae, which seem to be intracellular in origin. In specimens stained in borax carmine it is possible to trace fine branches of the protoplasm of the cells extending in between the lamellae throughout their entire length [pl.28, fig.15*pf*], and, when these plates are examined under a high power of the microscope, it is found that there is an anastomosing of the protoplasm of the adjacent branches [pl.28, fig.16], so that each cuticular area is surrounded on all sides by protoplasm.

When cross sections at the caudal end of the spiracle of the eighth abdominal segment are examined, it is found that the cuticle forming the cuticular pocket lies apparently in a nat-

ural cavity without any adjacent hypodermal cells. Such a cavity is represented on plate 28, figure 11*cep* in cross section and at figure 8*cep* in longitudinal section. In the latter case it will be noted that the cavity is continuous with the ventral cavity of the dorsal spines described above. In the drawings representing the epithelium surrounding the cuticular pocket, the outlines of the cells are not shown, because they could not be made out with certainty on the preparations. Because of the necessity for determining the homology of the threads of protoplasm extending between the lamellae of the cuticular pocket, whether more than a single thread arose from a single cell, which could not be done, it was thought best to leave out the cell boundaries. The preparations represented by the drawings give one the impression that we have to do with a syncytial structure, but it is not improbable that more carefully fixed material would show cell outlines. As it is almost axiomatic that, wherever cuticular structures are found in the Hexapoda there are epithelial cells closely associated with the cuticle from which they are derived, an explanation of the conditions existing here is thought necessary. The hypodermal cells, where they are adjacent to the cuticle and where they inclose the cavity, are long and well marked, while the cavity is filled with a homogenous, lymph-like staining structure. The specimens studied were not originally intended for histological study; the entire larvae were dropped into hot water and thence into either hot Perenyi's solution or hot vom Rath's picro-sublimate. The first impression on studying this structure was that it was an artifact due to improper fixation. But, when several series had been examined and it was found that the location and extent of the cavity was practically the same in all, this explanation had to be given up as improbable. The distance of the cuticle from the hypodermal cells sets aside the possibility of its always having been a cavity and that the structureless substance within the cavity is blood, because, if accepted, we have to meet the more difficult problem of explaining how the cuticle adjacent to the cavity could have been

formed. The prevalence of histolytic changes taking place among insects might make this a way out of the difficulty were it not that, in all the sections I have examined, I have never found an undoubted leucocyte within this cavity, while in most cases they were abundant in the body cavity adjacent to the hypodermal cells, and, in addition to the above, there was no indication of any histolysis taking place in any other part of the body. No hypothesis concerning this cavity is tenable other than that it was originally completely filled with the hypodermal cells that surround it and that its present condition is an acquired one. If sections are examined at about the level *l-m* of figure 8, plate 28, of which figure 13 is such a representation and which is the cephalic limit of this cavity, we shall find that some of the hypodermal cells, as at *vh* are filled with vacuoles, in the sections caudad of the one represented here, the vacuoles in places so completely fill the cells that there are left only delicate threads extending between the cuticle and basement membrane, while the cavities of the vacuoles are either empty or filled with a homogenous, nonstainable substance. Though it seems almost impossible to conceive how such a large cavity could have been formed by the vacuolization of the inner ends of the hypodermal cells, yet I have been unable to find any other explanation that would comply with all the conditions existing here. By this hypothesis we are able to explain the origin of the cuticle, which is the most difficult condition to explain and was unquestionably formed before the origin of the cavity. There undoubtedly exists some relation between this cavity and the dorso-ventral motion of the caudal spines. In all probability this motion, after the cells were modified into threadlike extensions, ruptured these threads, and in this way was secondary to the vacuolization of the cells in the formation of the cavity. I hope later to investigate this problem further and determine definitely if possible the origin of the cavity.

As was pointed out above, the larvae of Donacia palmata live at a depth of from 3 to 4 feet under water and

ooze and yet have none of those structures common to insects that would fit them for such a mode of life. What to the writer has been the most interesting phase of this investigation has been the determination of how these insects are able to obtain a supply of air. The most casual observers have noticed in walking over swampy places where there is an abundance of submerged vegetation that at each step great quantities of bubbles rise to the surface. These bubbles come in part from the crushed stems of the plants that have been trod on and are an ocular demonstration of the abundant air supply held by such plants. If one of the stems of an aquatic plant as Sagittaria be taken and sectioned transversely [pl.24, fig.1] we shall find that it is made up of a great quantity of small cells arranged in the form of anastomosing rings inclosing large spaces, and that fully two thirds of the area of the section is occupied by these spaces. Now, if another stem is sectioned longitudinally [pl.24, fig.2], we shall find that the cells are arranged in parallel rows with delicate cross walls dividing the longitudinal spaces into areas three or four times as long as broad. Each of these spaces is filled with air, and it is on such a supply that the larvae and pupae of Donacia depend. The larvae tap the air supply locked up in the stems of aquatic plants by pushing their caudal spines through the epidermis of the plant and rupturing the cells surrounding the air spaces. The air contained by such plants is of about the same richness in oxygen as the surrounding atmosphere. When the tissue of the plant is ruptured, the inclosed air, being lighter than the water, moves to the outer surface of the plant, and, if there were nothing to collect it, it would pass on to the surface of the water. But the spiracular openings being at the immediate base of the spines [pl.27, fig.19*s*] and the larva holding the apex of its abdomen close to the surface of the plant, the air is collected before it can escape into the water. Plate 28, figure 1, shows the apical portion of a growing stem with a larva with its caudal spines inserted into the tissues of a plant and in the act of respiring. On the many

stems examined were found numerous examples of larvae with their caudal spines pushed into the tissue of the plant clear up to their bases. In every case noted the larvae were at the apex of vigorously growing stems. As was described above, the larva eat large round holes in the apices of the growing stems, and this gnawing of the holes is undoubtedly done while the larva is respiring, as I have observed many larvae in the characteristic attitudes shown on plate 28, figure 1, and plate 27, figure 18. These figures, I think, show the larvae in a frightened attitude, which resulted from pulling the plant from the mud, and, as a result, one larva stopped feeding while the other stopped respiring.

Every investigator who has studied the function and structure of the caudal spines has arrived at a different conclusion. Perris, who studied Donacia sagittariae in 1848, was unable to determine the function of the caudal spines and thought there was a delicate membrane, that is the spiracles at the base of the spines, stretched over the opening, and that there was an osmotic interchange of the air of the tracheal system with that on the exterior of the membrane; but, when we consider the size of the membrane and that there is water, not air, on its exterior surface, this suggestion is seen to be incorrect. Von Siebold, who studied Donacia linearis in 1859, concluded that the openings at the base of the spines were functional spiracles, and that the larva obtained its air supply from the intercellular air spaces of the plant, and this was accomplished by the larva eating a hole into the tissue of the plant, into which it later inserted its caudal spines. From what follows it will be seen that von Siebold came nearest to the correct interpretation of the conditions existing here of any of the investigators. The next investigator to consider this question was Dr E. Schmidt-Schwedt in 1887, who studied the larva of Donacia crassipes. He found that some larvae, kept in a breeding cage, would, when the cage was darkened, insert the tips of their caudal spines into the tissue of the roots, but removed them as soon as the cage was lighted again.

This led him to study cross sections of the caudal spines, in which he found five cavities, two pairs above and a single large unpaired cavity below, which he thought opened near the tip.[1] From this he was led to conclude that the larvae, after inserting their caudal spines into the tissue of the plant, were able to draw the air in through this opening, through the ventral cavity of the caudal spines, and thence into the tracheal system and that there were no openings in the so called spiracles at the base of the spines. If Schmidt-Schwedt had studied the relation of the tracheal system to the caudal spines, he would have seen the fallacy of his conclusions. As I have pointed out above, this cavity is lined with hypodermis, does not connect in any way with the tracheal system, and is closed at its base by a thick layer of hypodermal cells [pl.28, fig.8*vc*]. If plate 28, figure 2, is examined, it will be noted that there is a line, *vv*, extending almost the entire length of the spine, which marks the ventral boundary wall of the paired ventral cavities, *pvc*, which are strongly chitinized and can be readily seen through the exterior of the spine when it is studied in optical section. It was the apex of this cavity which Schmidt-Schwedt mistook for an opening.

Dewitz[2] in 1888 published a short paper on the structure borne by the eighth abdominal segment in H a e m o n i a e q u i s e t i, in which he maintains that there are no openings in the caudal spines and that the structures at the base of the caudal spines are open spiracles directly continuous to the tracheal system.

[1]Though Schmidt-Schwedt figures such an opening, yet I reproduce his own description as a proof that he never saw such an opening. "Bei mikroskopischer Betrachtung des ganzen Anhangs kommt man zu der Auffassung, derselbe sei einfach hohl und auf der Unterseite in seiner ganzen Länge mit einem Längspalt versehen. Querschnitte zeigten, dass dies ein Irrthum und dass der innere Bau ungleich verwickelter ist. . . Der 5te unpaare Kanal ist hohl und von zarterer Wandung umgeben; auch auf der Unterseite ist er geschlossen. Nach der Spitze zu verjüngt er sich mehr und mehr und hört noch vor derselben ganz auf. Hier muss er offen sein. Zwar habe ich das an Querschnitten mit vollständiger Sicherheit nicht festsellen können, ebenso wenig wie das Gegentheil, aber es ergiebt sich das Erstere aus dem Umstand, dass sich dieser Kanal und zwar nur dieser beim Einlegen in Paraffin oder Stearin stets alsbald völlig mit der Einbettungsmasse anfüllte. *Berl. Ent. Zeit.* 1887. 31:328-29

[2]Dewitz, Dr H. Berl. Ent. Zeit. 1888. 32:5-6.

The following year Schmidt-Schwedt[1] replied to Dewitz, admitting that the organs at the base of the spines were true spiracles, but probably used only for expelling impure air, while the air in the plant cells was taken up by a double row of transverse slits found on the dorsal side of each caudal spine. Where these slits occur, they fit like a tongue and groove and are perfectly concealed. The air finds its way through the slits into the paired dorsal cavities and then by means of openings between the paired dorsal cavities and the paired ventral cavities, enters the paired ventral cavities along which it follows to the cuticular pocket. The rod-like cuticular structure of the cuticular pocket was known to Schmidt-Schwedt and though from the study of serial sections of this region he could not find any indication of an opening leading from the paired ventral cavity into the cuticular pocket, yet from numerous physical experiments, such as heating larva to drive out the air and then trying to determine its course, he maintained that the air found entrance from the paired ventral cavity through the walls of the cuticular pocket.

In 1900 E. Dwight Sanderson reviewed the work that had been done hitherto and made some original investigations on the structure of the caudal spines. He concluded that the ventral canal had absolutely no connection with the tracheal system, but that "the two upper passages," that is the paired dorsal cavities, "are open above, but can be readily closed by a wedge-shaped piece which runs along the top of the appendage," and that "the lateral passages," that is the paired ventral cavities, "open into the tube surrounding the spiracle," and that there is a double series of elliptical openings along the upper part of each lateral passage and that from these elliptical openings arise several tubes, each of which resembles a coarse miniature gill. He was unable to determine whether these tubes are open at the tips or not, but, if so, thought that they probably act as a sieve through which the air is admitted into the lateral passages; but he rather inclined to the view that they are closed, and that we have to do with a special structure for aerating the

[1]Schmidt-Schwedt, Dr E. Berl. Ent. Zeit. 33:299-308.

tracheae by osmosis. Sanderson's conclusions, to state them in another way, were that the paired dorsal cavities [pl.28, fig. 4*pdc*] are connected with the exterior at the point *ex*, and that the wedge-shaped apical portion of the caudal spines can be shut down tightly on either side so as to close this opening, and that the air finds its way from the paired dorsal cavities through a tube into the paired ventral cavities and thence is carried along this cavity to the tracheal system. From my own studies I have been led to conclude that there is never a natural opening leading into the paired dorsal cavities, and that, when there is such an opening present, it is an artifact. The cuticle at this point is thin and easily broken, while the cavity is lined with hypodermal cells; and I do not know of such a condition existing anywhere among the Hexapoda where there is a cavity opening to the exterior and lined by an epithelium. It is true that the mouth and rectal openings are lined with epithelium, but in both of these cases the lumen end of the cells is covered by a well marked cuticle. In addition to the above, I have found that the wedge-shaped portion is always rigid and not capable of any motion, while any air that might find its way into the paired ventral cavities, if an opening did exist, would be unable to reach the tracheal system, because the base of this cavity is completely plugged up by a portion of the cuticular pocket, as has already been described [pl.28, fig.8*w* and fig.6*pvc*]. I have been unable to find any tubes such as Mr Sanderson describes, while his so called elliptical openings are not openings but areas in the cuticle, that are very thin and transparent and very liable to lead one into error if one worked only with thick free-hand sections. When the caudal spines are mounted in Canada balsam, so that their dorsal surface can be studied, two rows of these elliptical openings can be seen forming the ectal surface of apparently well marked grooves or furrows, but these grooves or furrows are nothing more than the cavities of the paired dorsal cavities into which one looks through the transparent outer cuticle. This is further confirmed by the study of cross sections of the caudal spines;

for, no matter at what level sections are taken, the dorsal surface is always found to be convex, as is represented on plate 28, figure 4.

In order to explain how the larva of Donacia obtains its supply of air from the intercellular spaces of plants, I do not think it is necessary to assume any extraordinary structures for the caudal spines. The caudal spines are nothing more than projections of the body wall for rupturing the tissues of the plant; and, when this is accomplished, the air, being so much lighter than the surrounding water and having a strong tendency to follow along anything that will carry it to a higher level, simply follows along the outer surface of the caudal spines to their base, where it is taken up by the spiracles, while the two large longitudinal trachea connecting with the spines take up the supply of air and act as reservoirs for storing it between the air-taking periods.

When the larvae are ready to transform to pupae, they spin a tough, brownish cocoon, which is attached to the scars on the upper surface of the rhizome from which the leaf stalks have been shed. The silk is spun from glands opening in the mouth. The cocoons are not only water-tight but air-tight and are of a homogeneous consistency throughout without any indication of a thread-like structure. The bottom of the cocoon where it is attached to the plant is much thinner and lighter in color and is firmly glued to the surface of the plant [pl.22*o*]. In the case of p a l m a t a the cocoons are much smaller than the rhizome and always placed on its upper surface, distant from each other; but in those species that pupate on the roots of Sagittaria, Sparganium and Potamogeton, the cocoons are much broader than the roots and are placed singly, usually near the point of attachment of the roots to the base of the plant. Such a condition is shown well by plate 23, figure *b;* while in the case of D o n a c i a c i n c t i c o r n i s, which fastens its cocoons to the larger roots of N y m p h a e a a d v e n a, they are arranged close together in groups of five or six around the apices of the roots.

If the place from which a cocoon has been removed is examined, there are found two slits near one end [pl.30, fig.6ess] and a circular excavation near the center which penetrates through the cocoon into the tissues of the plant [pl.30, fig.6hh]. These slits were undoubtedly made by the caudal setae, as the openings are of the same size as the setae and the same distance apart and I believe it is the place where the larva was attached for the purpose of respiration while it was spinning its cocoon. Though numerous underground stems containing larvae were examined, yet I have never found a larva in the act of spinning its cocoon nor opened a cocoon with a larva with its caudal setae inserted in the slits. In every cocoon examined containing larvae except one, the caudal setae were in the opposite end of the cocoon from the slits, and in those cocoons containing pupae, the cast larval skins were in the opposite end of the cocoon from the slits. The only other way in which the slits could have possibly been made was by the mandibles, but, when they are studied and their weak structure and their shortness are noted, the impossibility of this explanation is apparent, and one is forced to the conclusion that there is no way that the slits could have been made other than by the caudal spines, and that the larvae must turn around in their cocoons after its completion and before shedding their last larval skin. In the case of the single exception noted the larva had probably completed its cocoon and had not yet turned around. The cocoons are usually larger than the inclosed larva, so that there would be room for it to turn around if it so desired. In the cocoons of Donacia aequalis and Haemonia nigricornis the circular excavation near the center of the bottom of the cocoon is wanting, and the pupa has to depend entirely on the air that can reach it through the paired slits.

Not only is the attachment of the larvae at the time they are spinning their cocoons important for furnishing an adequate supply of air for the larvae while they are undergoing the greatest muscular activity of their life, but an abundant supply of air is also undoubtedly important in freeing their cocoons of water. If, when the cocoon was completed, it were filled with

water, then, when the larva transformed to a quiescent pupa, it would be drowned in its own coffin. Such a calamity is undoubtedly averted by the larva entirely surrounding itself while spinning its cocoon by a quantity of air sufficient to fill the vacant space in the cocoon. A small quantity of water might be absorbed by the body of the larva or pupa, but it does not seem possible that the insect could absorb the amount of water the cocoon would hold; while, on the other hand, the underground stems to which the cocoons are attached are always imbedded in a soft, clayey ooze, and, if the water were absorbed by the body of the insect, then the interior of the cocoon would be lined with a clay deposit which would discolor it, whereas in every case the interior of the cocoons were just as clean as if they had been spun in the open air. It would be impossible for the plant to absorb the water because the bottom of the cocoon would be between the water and the epidermis of the plant except at the paired slits and the opening near the center.

The large excavation is always near the center of the cocoon and is undoubtedly made by the larva before transforming to a pupa. In this way the larva provides a continuous air supply for itself by tapping the store held in the intercellular air spaces of the plant. Since some individuals of Donacia live for 10 months or more in the cocoon, need for a copious and continuous air supply becomes apparent. That there is a bountiful supply can be readily proved by opening the cocoons under water, when it will be found that they are completely filled with air.

The pupa transforms to a beetle long before it is time for it to emerge. When it is ready to emerge, the end of the cocoon is broken off and the beetle crawls out. The ventral surface of most of the species of Donacia is densely covered with fine silken hairs, so that, when the beetle emerges from its cocoon, the air contained in the cocoon at this time is held to the ventral surface of the beetle by these silken hairs and in this way provides an air supply for it till it reaches the surface of the water. This silken covering is also of use to those species that lay their eggs under water.

KEY TO GENERA OF DONACIINAE

Larva

Sixth and seventh abdominal tergites each with a double row of setae of the same length as those found on the other tergites; the supraspiracular setae always present.....Donacia

Sixth and seventh abdominal tergites each with a double row of setae, most of which are twice as long as those found on the other tergites; the supraspiracular setae wanting.....Haemonia

Pupa

Tarsal segments expanded at either side; the elytra usually truncate at apex .....Donacia

Tarsal segments of a uniform width; the elytra usually excised with the outer angle strongly and the inner angle slightly prolonged at apex....Haemonia

Imago

Tarsi dilated, spongy beneath; the fifth segment of the tarsi subequal to or shorter than the second and third together.....Donacia

Tarsi not dilated, narrow, glabrous; the fifth segment of the tarsi distinctly longer than the second and third together.....Haemonia

DONACIA

The beetles of this genus are known as the long-horned leaf beetles because of their great resemblance to the species of the family Cerambycidae. They are elongate in form and of a greenish, bronze or purplish metallic color. The antennae are long and slender; the underside of the body is clothed with fine hair, giving them a silvery metallic appearance.

Species of Donacia are found in all parts of the United States and Canada, but they are more abundant in the northern, eastern and middle portions. Twenty species have been recognized which can be separated, so far as they are known, by means of the following tables:

Eggs

a Eggs large, 5mm long.....cincticornis

aa Eggs small, not over 2mm long

b Eggs covered with a gelatinous secretion, laid in a double row around a circular opening in a leaf.....palmata

bb Eggs not covered with a gelatinous secretion, and laid in a single row along the margin of a sedge leaf.....porosicollis

Larva

a Supraspiracular setae of the first four abdominal segments not extending caudad as far as the front margin of the posterior tergal band of setae

b Supraspiracular setae of the first six abdominal segments forming a single continuous group of setae

c Sternal setae of the fifth abdominal segment divided longitudinally by a mesal line into two groups; the posterior sternal setae of the mesothorax undivided

d Sternal setae of the seventh abdominal segment distinctly divided into two groups; the infraspiracular setae of the seventh abdominal segment not longer than broad...cincticornis

dd Sternal setae of the seventh abdominal segment continuous; the infraspiracular setae of the seventh abdominal segment twice as long as broad.....palmata

cc Sternal setae of the fifth abdominal segment not divided; the posterior sternal setae of the mesothorax not divided longitudinally into two groups

d Supraspiracular setae of the sixth and seventh abdominal segments coalesced with the outer ends of their posterior tergal setae .....subtilis

dd Supraspiracular setae of the sixth and seventh abdominal segments not extending as far caudad as the posterior tergal setae porosicollis

bb Supraspiracular setae of the first six abdominal segments divided transversely into two well marked groups.....aequalis

aa Supraspiracular setae of the first five abdominal segments extending caudad as far as the caudal margin of the posterior tergal setae emarginata

Pupa

a Antennae with the third segment distinctly longer than the second palmata

aa Antennae with the second and third segments subequal

b Prothorax distinctly tuberculate on the side; the pronotum with an impressed line at middle.....aequalis

bb Prothorax not tuberculate on the side; the pronotum not with an impressed line at middle

c First abdominal segment as long as, or longer than, the next four segments

d Mesosternum between the coxae nearly as broad as the coxae cincticornis

dd Mesosternum between the coxae about one half the width of the coxae or less.....subtilis

cc First abdominal segment as long as the next three segments emarginata

Imago[1]

a Head and thorax evidently pubescent above

b Elytra without pubescence

c Posterior femora with a small tooth.....hirticollis

cc Posterior femora simple.....pubicollis

bb Elytra evidently pubescent; posterior femora toothed..pubescens

[1]This table was compiled from a table by Charles W. Leng. Revision of the Donaciae of Boreal America. Am. Ent. Soc. Trans. 1891. 17:159–76.

aa Head occasionally, thorax never, pubescent
b Elytra truncate or subtruncate
c Form decidedly flattened, mesosternum about as broad as each coxa
d Thorax narrowed in front; posterior femora pluridentate in the male, simple in the female.....floridae
dd Thorax quadrate, or wider in front; posterior femora dentate in both sexes, the male often bidentate or tridentate
e Antennae with the second and third segments nearly equal
cincticornis
ee Antennae with the third segment much longer than the second
f Elytra truncate; first ventral segment of the male not depressed at middle
g Anterior tarsi of the male dilated.....palmata
gg Anterior tarsi of the male simple.....hypoleuca
ff Elytra subtruncate; form more convex; first ventral segment of the male depressed at middle.....piscatrix
cc Form more convex; mesosternum narrower than the coxa
d Eyes of normal size; sutural margin of the elytra straight, except in distincta
e Thorax punctate, not, or scarcely, tuberculate
f Thoracic punctures coarse, uniform; median furrow not distinct and punctured at bottom
g Second and third segments of the antennae subequal
subtilis
gg Second segment of the antennae about one half the length of the third.....rugosa[1]
ff Thoracic punctures uneven, thorax rugose with punctures between the rugosities; median furrow distinct, entire, and not punctured at bottom.....porosicollis
ee Thorax uneven on the disk, tuberculate on the sides
f Sutural margin of the elytra straight
g Elytra with transverse indentations.....aequalis
gg Elytra not with transverse indentations; posterior femora of the male dentate, simple in the female
tuberculata
ff Sutural margin of the elytra sinuate.....distincta
dd Eyes small; thorax tuberculate; sutural margin of the elytra sinuate .....harrisii
bb Elytra rounded at tip; the sutural margin sinuate posteriorly; form convex; mesosternum narrow
c Thorax depressed without basal and medial grooves
d Posterior femora dentate in both sexes.....pusilla
dd Posterior femora dentate in the male only.....femoralis
cc Thorax convex, punctured, and with an evident basal and a more or less evident medial groove

[1]This form is considered a variety of subtilis by Mr Leng, but, if the character given above is worthy of group value in the case of cincticornis, palmata, hypoleuca, and piscatrix, I can see no reason why rugosa should not be entitled to specific rank, and have so considered it here.

d Posterior femora pedunculate; thorax closely punctulate
c Legs dark
f Posterior femora dentate in both sexes.....emarginata
ff Posterior femora dentate in the male only.....metallica
ee Legs rufo-testaceous; posterior femora dentate in both sexes flavipes
dd Posterior femora elliptical, dentate in both sexes; thorax sparsely punctured; legs rufo-testaceous.....rufa

Donacia cincticornis

Egg. 5mm long, rounded at each end, the sides subparallel, slightly concave on one side and convex on the other, naked, laid in an irregular mass on aquatic plants, and attached by one end [pl.21, fig.3; pl.24, fig.3].

Larva. Mandibles bidenticulate with a few crenulations within [pl.25, fig.1]; eyes apparently wanting; all the segments of the leg with only a few setae, the basal segment with eight to 10, each of the others with three or four [pl. 25, fig.3]; the labrum four sided, emarginate in front with eight marginal setae, the two lateral ones of each side distant from the median ones and from each other, with six discal setae, the distal pair about one half the length of the median pair, the proximal pair as long as the distal and median pairs together, two lateral setae, each extending beyond the front margin of the labrum, and two sensory pits [pl.25, fig.6]; the anterior tergal setae of the mesothorax and metathorax divided into three well marked groups, those of the first six abdominal segments straight and broad and not divided, those of the seventh segment consisting of an irregular row of setae; the posterior tergal setae of the first six abdominal segments of about the same length as the anterior tergal setae, those of the seventh abdominal segment almost as long as the width between the spiracles; the supraspiracular setae of the first six abdominal segments broad[1] and well marked and coalesced with the lateral extensions of the anterior tergal setae, and not coalesced with the lateral extensions of the posterior tergal setae; those of the seventh abdominal segment consisting of three or four setae and hardly more than a continuation of the anterior tergal setae; the infraspiracular setae well marked, triangular in outline, becoming smaller caudad; the anterior and posterior sternal setae of the prothorax broad and separated, those of the mesothorax and metathorax broad and separated except at middle, the

[1] By this expression is meant not a single seta, but the group of setae known as the supraspiracular setae, and it is used in this sense throughout.

sternal setae of the first three abdominal segments broad and not divided longitudinally, those of the fourth abdominal segment narrow and hardly continuous at middle, those of the fifth, sixth and seventh abdominal segments divided longitudinally; the pedal setae of the first three abdominal segments almost as long as the width of the segment, those of the last four segments smaller and circular in outline [pl.29, fig.1].

Pupa. Whitish; legs, wing-pads and antennae not closely attached to the body; the second and third segments of the antennae subequal; the pronotum with a distinct median furrow and without lateral tubercles; the first ventral abdominal segment as long as the next five. Length, 11mm; width, 4mm.

Cocoon. Black; oval in outline, rotund, concave on the ventral surface; and attached in groups to the apices of the large lateral stems of Nymphaea advena. Length, 13mm; width, 7mm.

Described from specimens loaned by the Museum of Comparative Zoology and collected by George Dimmock at Canobie Lake, N. H., July, 1887.

Donacia palmata

Egg. 1mm long, opaque white, both ends bluntly rounded, the sides parallel; laid in a double row, 40 or 50 eggs in a mass, the mass completely surrounded by a thick, gelatinous covering, on the under surface of the leaves of Nymphaea advena and of Castalia odorata [pl.21, figs. 1 and 4; pl. 24, fig.4].

Larva. Mandibles apically bidenticulate, the inner margins with poorly marked crenulations [pl.25, fig.11]; eyes present, four in number, three in the anterior row [pl.25, fig.10]; the segments of the legs with few setae, four or five setae to a segment [pl.25, fig.12]; the labrum four sided, with eight long marginal setae, the six outer setae much the longer and equidistant from each other, the median pair about half the length of the others, with six discal setae, the distal and median pairs near the middle of the labrum and proximad of the sensory pits, the distal pair not more than half the size of the median pair, the proximal pair distinctly longer than the median pair, the median pair more distant from each other than either the distal or proximal pairs, the two lateral setae long and slender, and with four sensory pits [pl.25, fig.9]; the anterior tergal setae of the mesothorax and metathorax and first three abdominal segments divided into three groups, those of the thoracic and first two abdominal segments widely separated, those of the other segments not so well marked, the anterior tergal setae of the first five abdominal segments attenuated laterally

and indistinctly connected with the supraspiracular setae, those of the sixth and seventh segments not attenuated laterally, and distinctly separated from the supraspiracular setae, the anterior tergal setae of the seventh segment not more than one half the width of those of the other segments, the posterior tergal setae of the seventh segment broad and continuous; the supraspiracular setae of the first six abdominal segments transverse, well marked, but not extending caudad as far as the posterior tergal setae, those of the seventh abdominal segment but little broader than the band of anterior tergal setae; the infraspiracular setae broad and somewhat oblique; the anterior and posterior sternal setae of the thoracic segments distinctly separated, the posterior sternal setae of the prothorax divided longitudinally, the sternal setae of the first four abdominal segments broad and continuous, those of the fifth and sixth abdominal segments smaller and divided longitudinally, those of the seventh abdominal segment forming an almost continuous but attenuated band at middle, and coalescing at its outer ends with the pedal setae; the pedal setae of the first six abdominal segments well marked and distinct, not coalesced with the sternal setae [pl.29, fig.2].

Pupa. White; legs, wing-pads, and antennae not closely attached to the body; the third segment of the antennae almost twice the length of the second; pronotum with an indistinct median furrow and not tuberculate on the sides in front; the first ventral abdominal segment as long as the next three. Length, 11mm; width 5mm.

Cocoon. Brownish; oval in outline; and attached in groups of three or four on the leaf scars of the underground stems of Nymphaea advena. Length, 11mm; width, 5mm.

Described from numerous specimens collected by J. O. Martin and the writer on the stems of Nymphaea advena at Ithaca N. Y.

Donacia subtilis

Larva. Mandibles bidentate, the inner margins hardly crenulate [pl.25, fig.15]; eyes present, five in number, arranged in two rows [pl.25, fig.13]; the three segments of the legs with numerous large setae of varying lengths [pl.25, fig.14]; the labrum distinctly five sided, with eight marginal setae, the outer distinctly longer than the six inner, which are subequal in size and adjacent and distinctly separated from the lateral marginal setae, with six discal setae, the proximal pair long and slender, the median and distal pairs almost in a line, the median pair the longer, with two lateral setae which are as stout and as long as the proximal discal setae, and with two sensory pits [pl.25,

fig.17]; the anterior tergal setae of the mesothorax and metathorax divided into three groups, those of the first six abdominal segments continuous and connected with the supraspiracular setae, those of the seventh segment continuous, but with their lateral extensions widely separated from the supraspiracular setae, the posterior tergal setae of the mesothorax distinct from all the other groups, those of the metathorax with their outer ends curving cephalad and slightly coalescing with the anterior tergal setae, those of the first five abdominal segments continuous and straight and of about the same length as the anterior tergal setae, those of the sixth abdominal segment only slightly separated from the supraspiracular setae, which in this segment extends much farther caudad than in the others, those of the seventh abdominal segment curved and extending from one spiracle to the other; the supraspiracular setae broad, well marked, those of the seventh segment small, consisting of only a few setae; the infraspiracular setae of medium size and oblique, those of the seventh segment behind the spiracle and near the apex of the posterior tergal setae; the anterior and posterior sternal setae of the thorax distinctly separated and divided longitudinally into two groups, the sternal setae of the first five abdominal segments square in outline and continuous, those of the sixth and seventh segments divided longitudinally into two groups; the pedal setae well marked and not joined to the sternal setae [pl.29, fig.3].

Pupa. White; legs, wing pads, and antennae not closely attached to the body; the second and third segments of the antennae subequal; the pronotum not with an impressed line nor tuberculate on the side in front; the first ventral abdominal segment as long as the next four. Length, 9mm; width, 5mm.

Cocoon. Brownish; oval in outline; and attached along the middle line of the leaf of a sedge. Length, 10mm; width, 5mm.

Described from numerous specimens loaned by the United States National Museum and probably collected by Messrs Hubbard and Schwarz on rushes along the Detroit and St Clair rivers in August 1873.

Donacia porosicollis

Egg. 1½mm in length; opaque white in color; each end bluntly rounded, the sides subparallel, naked, not surrounded by a gelatinous covering; laid in a single row along the edge of the leaves of a sedge under water, and attached by one side [pl.21, fig.2; pl.24, fig.3, 4].

Larva. Mandibles distinctly medially bidentate with well marked teeth within [pl.26, fig.1]; eyes present, five in number,

arranged in the form of a very irregular trapezoid [pl.26, fig.6]; all the segments of the leg with many setae [pl.26, fig.5]; labrum indistinctly five sided, with eight marginal setae, the six median ones short, subequal in length, and equidistant from each other, the lateral ones long and distant from the median ones, with six discal setae, the distal pair in front of a line drawn between the median pair and about as long as the median pair, the median pair long and stout, the proximal pair very long and slender, the distal and median pairs in front of the distal pair of sensory pits, with two lateral setae which are long and stout, and with four sensory pits [pl.26, fig.3]; the anterior tergal setae of the mesothorax and metathorax divided into three groups, those of the first five abdominal segments not divided and their lateral extensions united with their supraspiracular setae, those of the sixth and seventh abdominal segments not divided and distinctly separated from their supraspiracular setae, the posterior tergal setae of the mesothorax slightly joined with the lateral groups of the anterior tergal setae, those of all the other segments straight and distinct; the supraspiracular setae not extending on to the annulet of the posterior tergal setae, those of the seventh abdominal segment not consisting of more than three or four setae; the infraspiracular setae of the abdominal segments of medium size, oblique, those of the seventh segment not reaching cephalad as far as the spiracle; the anterior and posterior sternal setae of the thoracic segments distinctly separated, their posterior sternal setae divided longitudinally into two distinct groups; the pedal setae circular in outline and separated from the sternal setae; the sternal setae of the first five abdominal segments forming a continuous group, those of the sixth and seventh abdominal segments divided longitudinally, those of the seventh segment not consisting of more than three or four setae [pl.29, fig.4].

Cocoon. Brown; oval in outline; and attached along the middle line of the leaf of a sedge (Juncus). Length, 11mm; width, 6mm.

Described from specimens loaned by the Museum of Comparative Zoology and collected by Mr H. G. Hubbard in marshes of Detroit river, Michigan, in August 1873.

Donacia aequalis

Larva. Mandibles bidenticulate, with one or two well marked teeth within [pl.26, fig.8]; eyes apparently wanting; each segment of the leg with a number of long setae [pl.26, fig.12]; the labrum distinctly five sided, the front margin deeply emarginate

with eight marginal setae, the six median setae equidistant from each other and subequal in size, the outer ones more distant and longer, with six discal setae, the distal and median pairs almost in a line and subequal in length, the proximal pair long and slender, with two lateral setae placed near to the proximal margin of the labrum, and with four sensory pits [pl.26, fig.11]; the anterior tergal setae of the mesothorax and metathorax divided into three groups, those of the first seven abdominal segments continuous but slightly broader at the middle of abdominal segments two, three and four, the posterior tergal setae continuous, those of the seventh abdominal segment extending as far as the spiracle; the supraspiracular setae of the first six abdominal segments divided transversely, the cephalic group being joined to the outer ends of the anterior tergal setae and the caudal group triangular in outline and midway between the anterior and posterior tergal setae; the infraspiracular setae almost as broad as the segment, oblique; the anterior and posterior sternal setae distinct, the posterior sternal setae of the thorax divided longitudinally, the sternal setae of the first six abdominal segments distinct and not divided longitudinally, the sternal setae of the seventh abdominal segment small and divided longitudinally into two groups, the lateral margins of the sternal setae of the first two abdominal segments slightly coalesced with the pedal setae; the pedal setae broad and well marked [pl.30, fig.1].

Pupa. White; the legs, wing pads, and antennae not closely attached to the body; the second and third segments of the antennae subequal; pronotum with a well marked median line-like grove and a prominent tubercle on each side in front; the first ventral abdominal segment as long as the next four. Length, 8mm; width, 3mm.

Cocoon. Dark brownish, oval in outline, attached to the side of the roots of Sagittaria and much wider than the roots to which they are attached. Length, 8mm; width, 4mm.

Described from specimens collected on the roots of Sagittaria latifolia and Sagittaria rigida at Ithaca N. Y.

Donacia emarginata

Larva. The mandibles with two median teeth and well marked denticulations within, the surface with two or three setae [pl.26, fig.18]; the eyes apparently wanting; the three segments of the legs with numerous setae [pl.26, fig.16]; the labrum four sided, with eight marginal setae, the six median setae adjacent, subequal in size, and at the bottom of a slight emargination, the

lateral ones two or three times as long as the median ones and on the outer angles of the labrum, with six discal setae, the distal and median pairs in a line distad of the anterior pair of sensory pits, subequal in length, the proximal pair twice as long, stout, with two lateral setae, which are stout and near the middle of the lateral margin, and with four sensory pits [pl.26, fig.13]; the anterior and posterior tergal setae continuous and coalesced laterally with the supraspiracular setae; the supraspiracular setae long, extending almost the entire width of the segment; the infraspiracular setae forming a broad triangular patch, broadest on its cephalic margin and extending almost across the segment, the adjacent margins of the supraspiracular and the infraspiracular setae of the seventh abdominal segment coalesced; the anterior and the posterior sternal setae of the prothorax distinctly separated, those of the mesothorax coalesced on the median line, those of the metathorax broad and coalesced throughout their entire extent; the sternal setae of the first six abdominal segments broad and coalesced with the pedal setae, the sternal setae of the seventh abdominal segment minute in comparison with those of the other segments and separated from the pedal setae [pl.30, fig.2].

Pupa. White; the legs, antennae and wing pads not closely applied to the body; the third segment of the antennae subequal in length to the second; the pronotum not with a well marked median, impressed line and not with a tubercle on either side in front; the first ventral abdominal segment not quite as long as the next three. Length, 10mm; width, 5mm.

Cocoon. Dark brownish, oval in outline, attached to the side of the small roots of Sparganium androcladium and much wider than the roots to which they are attached. Length, 10mm; width, 6mm.

Described from numerous specimens collected by Dr J. G. Needham at Saranac Inn N. Y. on the bases of the roots of Sparganium androcladium [pl.23].

HAEMONIA

This genus contains a single American species, Haemonia nigricornis, which occurs rarely throughout the United States and Canada. The adult is quite similar in general appearance to the species of Donacia. It can be readily recognized by having the tarsus narrow, glabrous, and its apical segment very long, and the inner and the outer margins of the elytra at apex usually produced into well marked teeth.

Haemonia nigricornis

Larva. The mandibles bidenticulate, with distinct smaller teeth within, the surface with three setae [pl.27, fig.1]; the eyes present, five in number [pl.27, fig.5]; the basal segment of the leg with four or five setae and the surface densely papillate [pl.27, fig.4]; the labrum emarginate in front with four long marginal setae, the outer the longer, with four discal setae, the distal pair not much more than one half the length of the proximal pair, with two long lateral setae, and four sensory pits [pl.27, fig.2]; the anterior tergal setae of the mesothorax and the metathorax divided into three well marked groups, those of the first five abdominal segments straight and not divided, those of the fourth and fifth abdominal segments broader at middle than at the sides, those of the sixth and seventh abdominal segments straight and consisting of from four to eight setae, most of which are larger than those of the ordinary type; the posterior tergal setae of the mesothorax and metathorax and first five abdominal segments straight and of about the same length as the anterior tergal setae, those of the sixth and seventh abdominal segments similar in outline but consisting mainly of setae twice the length of those of the ordinary type, the seventh abdominal segment with about four extra setae on the front margin near the middle; the supraspiracular setae of the first five abdominal segments small and coalesced with the anterior tergal setae, those of the sixth abdominal segment distinctly separated from the anterior tergal setae, those of the seventh abdominal segment wanting; the infraspiracular setae of the first seven abdominal segments all of about the same size, small and oblique; the anterior sternal setae of the prothorax wanting, the posterior sternal setae indistinct and divided longitudinally into two groups, the anterior and posterior sternal setae of the mesothorax and metathorax indistinct and not joined, the posterior sternal setae of these segments divided longitudinally, the sternal setae of the abdomen in small groups and not divided; the pedal setae of the abdomen well marked on the anterior segments and becoming smaller on the posterior segments; the caudal margin of the seventh abdominal tergite produced into a blunt projection and constituting the apex of the abdomen [pl.30, fig.3].

Pupa. White; the legs, wing pads, and the antennae not closely attached to the body; the second and third segments of the antennae short and subequal; each shorter than either the fourth or fifth; the pronotum with a prominent depression at the middle in front, the front angles protuberant, the sides emarginaté; the first ventral abdominal segment almost as long

as the next four; the elytra usually with the outer angle strongly and the inner angle slightly prolonged at apex; the tarsal segments of a uniform width. Length, 7mm; width, 4mm.

Cocoon. Light brownish, oval in outline, and attached to the side of the small roots of an aquatic plant[1]; the cocoons broader than the roots. Length, 6mm; width, 3mm.

Described from specimens collected at Ithaca N. Y. by the writer and by Messrs Hubbard and Schwarz along the Detroit and St Clair rivers, Detroit Mich.

Subfamily GALERUCINAE

This subfamily includes several genera and species, a single one of which is found on the leaves of Nymphaea advena. The larvae feed on the epidermis of the leaves, and where this plant occurs they are quite abundant.

Galerucella nymphaeae

Egg. Oblong or short cylindric with smoothly, obtusely rounded ends; yellow, shining. The egg cluster consists of a small number (6 to 20) eggs placed closely side by side on end on the upper surface of a floating leaf of Nymphaea or Brasenia.

Larva. Head black; the antennae mere tubercles, three jointed; the labrum three sided, the distal and lateral margins in the form of a continuous convex curve constituting one side, the remaining sides formed by the proximal end of the labrum with an angle on the median line, the distal margin with a row of comb-like bristles attached to the ental surface, two long discal and two long lateral setae, the two groups forming a transverse line, and four marginal setae [pl.27, fig.9]; the mandibles tridentate, the two inner teeth subequal, the outer one much shorter [pl.27, fig.8]; the thorax and abdomen black above except at the sutures and with fine whitish fuscous lines dividing the black into distinct areas—there is such a line on the meson of the notum of the three thoracic segments, and a line on each abdominal segment dividing it into two parallel transverse bands, the posterior being the longer, at the end of each of these bands a quadrangular spot, and laterad of each anterior spot another subequal in size which bears the spiracle, and laterad of the spiracle a much larger spot as long as the

[1]The European species are found on the roots of Potamogeton natans, and LeConte and Horn record the American species from Potamogeton; but by an oversight I neglected to record the name of the plant on which I found them.

width of the segment; the sternum of the thorax and abdomen pale except a spot on either side of the thorax laterad of the legs and homodynamous spots on each abdominal segment, a spot on either side mesad of the spots just described, and a median broad spot; and the last ventral abdominal segment with a well developed proleg, legs blackish except at the sutures.

Pupa. Black, except the sternum of the thorax and abdomen, the apical segment of the abdomen which is covered by the cast larval skin, the basal segments of the legs, and a median tergal line which are yellowish; the legs, wing pads, and antennae not closely joined to the body; the very young pupae are lighter in color. Length, 7mm; width, 4mm.

Described from specimens collected at Ithaca N. Y. and from Saranac Inn N. Y. by J. G. Needham.

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Part 6

AQUATIC NEMATOCEROUS DIPTERA

BY OSKAR AUGUSTUS JOHANNSEN

In the following pages will be given an account of the life histories of a number of small flies, commonly known as black flies, (Simuliidae), mosquitos, (Culicidae), and midges, (Blepharoceridae and Chironomidae). The material on which this study is based was for the most part collected in the vicinity of Ithaca N. Y., though some of it came from Saranac Inn N. Y. and elsewhere. The larvae were collected by means of a small hand net from the ponds; or swept by means of a brush into a cloth "sag-net" from the surface of the rock on the bottom of the shallow creeks in the manner described by Professor Needham in United States National Museum bulletin 39, 1899, part O, page 5. The material thus collected was then transferred to the breeding cages. These cages for the pond-water larvae consist of small glass jars containing some water plants. For those forms that require rapidly flowing water a jar was used from which the water was drawn by means of a continuous siphon as rapidly as it entered.[1]

The material was collected during the summer of 1901, and studied during the fall of the same year in the entomological laboratory of Cornell University, under the direction of Prof. J. H. Comstock, to whom I wish to express my thanks for his advice in the preparation of this work. I also desire to acknowledge my obligation to Prof. J. G. Needham, of Lake Forest University, who suggested the work, directed its course and supplied me with material; to Professor Aldrich, of the University of Idaho, Professor Smith, of New Jersey, Professor Kellogg, of Leland Stanford Jr University and Messrs MacGillivray and Houghton for material from various localities.

The object of the paper is to give the distinctive generic and specific characters of larvae and pupae of the forms studied,

[1] See Comstock. Insect Life, p.330.

tabulated in the form of keys, to enable any one having an elementary knowledge of entomology to identify members of this interesting group of insects.

The Simuliidae are treated at greater length than the others, more material being at hand for the study of this family. In the descriptions of the wings of the adult, the nomenclature of Comstock and Needham (1898) has been followed.

The aquatic larvae of the Diptera may be distinguished from aquatic larvae of other insects by the absence of true, jointed thoracic legs; in having abdominal prolegs, or in being entirely legless; in the most degenerate forms the head is reduced and retracted within the pointed apex of the thorax, and no appendages of the imago are visible. Their pupae either have prominent prothoracic dorsal spiracles, often borne at the end of the antennaelike processes, or the pupa is formed in the hardened larval skin. The adults have but two wings, or in a few rare cases are apterous. The presence of the balancers and the absence of caudal filaments distinguish them from the males of the Coccidae. The most familiar examples are house flies and mosquitos.

The Diptera in general are divided into two suborders:

Larvae with a differentiated head; pupae free or inclosed in the larval skin; in either case the larval skin bursts for the extrication of the pupa or imago in a T-shaped opening on the back of the anterior end, or rarely in a transverse rent between the eighth and ninth abdominal rings. The imago lacks the frontal lunule and ptilinum. Examples are the gnats, midges, crane flies, horse flies, snipe flies, robber flies, etc. (Nematocera and Brachycera) ..... Orthorrhapha

Larvae without differentiated head; pupae always inclosed in the hardened larval skin (forming the so called puparium); the imago always escaping from the anterior end through a circular orifice. Frontal lunule present; ptilinum usually present. Examples of this suborder are flesh and horse flies, bots, drone flies, etc. Among these are but few having aquatic larvae—a few Syrphidae, some of the Sciomyzidae[1] and other Acalyptrate Muscids.... Cyclorrhapha

[1] See N. Y. State Mus. Bul. 47. 1901. p.577.

KEY TO FAMILIES OF NEMATOCEROUS DIPTERA

Larvae

1 Mandibles opposed, with the jaws moving in a horizontal plane; when the mouth parts are rudimentary, the larva has 13 segments and is peripneustic[1] (2).....Nematocera

Mandibles parallel, their motion in a vertical plane; if the motion is obliquely inward, then the head is not sharply differentiated from the first thoracic segment .....Brachycera

2 Larva with fully differentiated head, nonretractile, which contains the first ganglion and sometimes the eyes, peripneustic or amphipneustic,[2] with breathing tube or tracheal gills.....(3).....Tribe Eucephala

Larva with only a "jaw capsule" (Kiefer kapsel).....(14)

3 Terrestrial forms, living in the earth, in rubbish, under bark, or in fungi....(4)

Aquatic or semiaquatic.....(6)

4 Larvae without thoracic prolegs.....(5)

With thoracic prolegs. Living under bark.....Ceratopogon

5 Body bristly; head usually with eyes.....Bibionidae

Body not bristly, head usually without eyes .....Mycetophilidae

6 Prolegs at least on fourth and fifth segments (i. e. on first two abdominals) (7)

No prolegs on these segments.....(8)

7 Spiracles on the first and last segments, with tracheal gills, and a very long membranous breathing tube.....Ptychopterinae

No long respiratory tube; larva swimming in a U-shape.....Dixidae

8 Body flattened, onisciform, and usually with suckers underneath.....(9)

Body more or less cylindric, without suckers on the intermediate segments...(10)

9 The segments alternating small and large, the outline of the body, serrate. Living in rapid flowing streams.....Blepharoceridae

The segments gradually larger at the middle of the body, becoming smaller again toward the posterior end.....Psychodidae

10 With thoracic prolegs.....(13)

Without thoracic prolegs.....(11)

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[1] Spiracles confined to the median segments. The Chironomidae usually have jaws which move in oblique planes.

[2] Spiracles confined to the first and last segments.

11 Thorax enlarged; abdomen usually with long hairs; usually a complex respiratory apparatus at the anal end.....Culicidae
Body much elongated.....(12)
12 Last segment of the abdomen with two fleshy points.....Rhyphidae
Last segment tapering, often with a few long hairs. Body snakelike, segments of nearly uniform length. (Ceratopogon).....Chironomidae
13 With anal prolegs and blood gills. (Chironomus, Tanypus, etc.).....Chironomidae
Without anal prolegs; a broad abdomen, with a terminal sucker; head with a pair of fanlike organs (black flies).....Simuliidae
14 With rudimentary mouth parts; body with 13 segments; peripneustic (i. e. spiracles on the median segments). Gall gnats.....Cecidomyiidae
With biting jaws. Head incomplete, small, retractile, not containing nerve ganglia; 12 body segments; posterior stigmata usually with some fleshy filaments (crane flies).....Tipulidae

Pupae

1 Prothoracic spiracles, if present, borne on appendages (Nematocera).....(2)
Prothoracic spiracles sessile.....Brachycera
2 Nonaquatic. Leaf miners or gall makers (Cecidomyiidae); larvae living in fungi (Mycetophilidae); larvae living in the earth (Bibionidae); larvae living under bark (some Ceratopogon)
Aquatic or semiaquatic.....(3)
3 Pupae in a fibrous cocoon.....(4)
Without cocoon, sometimes in the old larval tube.....(5)
4 Cocoon cornucopialike, the coarse thoracic filaments of the pupa projecting. These filaments are usually few in number.....Simuliidae
Thoracic filaments of the pupa if present, entirely within the cocoon, the latter usually subcylindric.....Some Chironomidae
5 Body convex, hard shelled, and attached limpetlike to the rock.....(6)
Not attached nor limpetlike.....(7)
6 Shield-shaped, flattened. Thoracic breathing tubes are subcylindric[1].....Some Psychodidae

[1] See Professor Kellogg's paper in *Ent. News*, Feb. 1901.

Convex, oval; breathing tubes composed of several lamellae.....Blepharoceridae

7 Prothoracic respiratory appendages simple, slender, antennaelike; pupa sluggish or motionless.....(8)

Prothoracic appendages short and pointed, or club shaped, or composed of numerous fine filaments, or entirely wanting .....(9)

8 First abdominal segment about as long as those following it.....Some Psychodidae

First abdominal segment about half as long as those following it.....Tipulidae

9 Prothoracic appendages short and pointed.....Rhyphidae

These appendages not as above.....(10)

10 With two rounded paddlelike appendages at the caudal end.[1] Pupa active.....Culicidae

Without distinct paddles (if present, then pointed, and with ciliate margin)...(11)

11 The caudal end with two pointed processes and usually bent forward over the pectus; the pupa resting on its side.....Dixidae

Prothoracic appendages either many branched, simple or apparently wanting, the pupa in the larval tube (Chironomus) or active, Culexlike (Tanypus); or floating nearly motionless (Ceratopogon) .....Chironomidae

The above keys are modifications of those given by Mr C. A. Hart, Illinois State Lab. Nat. Hist. Bul. 1895. v.4, art.6, p.186-89.

To determine the imagines, the reader is referred to Comstock's *Manual for the Study of Insects*, or to Williston's *Manual of the North American Diptera.*

Family BLEPHAROCERIDAE

Net-winged midges

These flies are of moderate size, elongate and bare, with long legs and broad wings. The ocelli are present; the proboscis is elongated; the antennae are slender, composed of from six to 16 joints, clothed with short pubescence. The thorax has a distinct though interrupted suture. The empodium is very small and the pulvilli are wanting. The wings are broad, without hair, with a projecting anal angle; characterized by a network of fine lines which extend in various directions and not

[1] Corethrella (q. v.) is an exception: having two pointed caudal lobes.

influenced by the veins of the wing, though apparently constant in position in a given species.

The larvae live in running water. The head has a pair of slender antennae; the cephalothorax and the following segments each with a conical process bearing a bunch of bristles; pupa flattened, inactive and free, inclosed in a semioval shell-like skin, the anterior end with erect breathing tubes; on the underside the skin is soft and transparent.

Genus BLEPHAROCERA Macq.

This genus is distinguished from the other genera of this family, in that the eyes are holoptic (i. e. contiguous); bisected by an unfaceted cross band or by a single groove. The radius (Comst.) is three branched (i. e. the second longitudinal vein is not furcate); and the vein M_3 with its basal end free and beginning in the middle of the wing. See figure in Comstock's *Manual*, p. 433.

Blepharocera capitata Loew

Berl. Ent. Zeit. 1863. Centur. 4; p.43

So far, but one species of this family, Blepharocera capitata Loew, has been recorded from this State. It is very abundant in several of the ravines about Ithaca, and larvae have been found in other parts of the State. The first adults observed the past year, emerged about June 1, and they had all disappeared by July 15. The fact that their season of flight is a short one, and that they are found only near the water's edge in deep and comparatively inaccessible ravines, accounts for the scarcity of the species in collections. The life history of this species has already been given by Prof V. L. Kellogg in *Entomological News* for January 1900, p.305–18; and the imago has been described by Loew in the *Berliner Entomologische Zeitschrift*, 1863, p.43. The life history may be briefly stated as follows:

The eggs have not yet been discovered. The larvae may be found throughout the month of May, in shallow but swiftly flowing water. About Ithaca they have been found most fre-

quently in the little stream flowing through Coy glen, in Six Mile creek, and in Cascadilla creek; and have also been collected by Mr A. D. MacGillivray in a brook near Axton N. Y. During the early part of May the larvae are still quite small, the smallest found measured 2.5mm in length, and were scattered over the smooth rock bed of the stream where the water is swift, but only about 1 inch in depth. If removed from the brook and placed in vials or still water, they soon die, usually within a few hours.

The larva is a curious black creature, flattened, its length being about two and one half times its breadth at widest part, each of the four intermediate segments separated from each other and from the cephalic and anal portion by deep constrictions, thus dividing it into six distinct parts. Kellogg says (in the paper just quoted) that the anterior, apparently single segment is composed of the fused head and three thoracic segments, while the most posterior part is composed of the last two abdominal segments, the intervening parts representing each a single abdominal segment. The larva is footless, but each body part bears a pair of small unsegmented, pointed projections, situated on the ventral aspect of the lateral margins. The organs of locomotion consist of six suckers, one of which lies on the median ventral aspect of each body part; thus there is but one sucker for the combined head and thorax, and but one for the last two abdominal segments. By means of these suckers, the larva clings to the rock bed of the stream. The larva occasionally moves about on the smooth surface of the rock, from the necessity of getting farther into the stream as the water lessens in quantity, and perhaps also, for seeking its food—the diatoms on the surface of the rock. The structure of the sucker is well described by Kellogg (*loc. cit.*). The larvae breathe by means of small tufts of short thick tracheal gills, of which there is a pair on the ventral surface of each of the first to the fifth abdominal segments. On the last segment there are two pairs of much larger, thicker, fingerlike processes, perhaps also tracheal gills. The writer collected during May many liv-

ing larvae, and attempted to rear them, by placing them in aquaria of running water, but succeeded with only four specimens. The first of these cast its larval skin on May 20; the second on the 25th, the third on the 26th, and the fourth on the 27th. The casting of the larval skin is most rapidly accomplished. A larva in the breeding cage attracted attention because of its grayish color, not so black as usual, the pale color owing, probably, to the skin being loosened. A moment later, perhaps half a minute, the empty larval skin was seen floating away, leaving the cream-white pupa on precisely the same spot which had been occupied but a moment before by the larva. In the new pupa, the constrictions of the body so distinctive in the larva, were still plainly visible; within half an hour they began to disappear, and the color gradually became darker. In from three to four hours the pupa had assumed its characteristic shape, and the coal-black color. The four empty larval skins examined, all had a small irregular break on the ventral surface just cephalad of the first sucker, and another small T-shaped opening on the dorsal surface opposite the one on the ventral. The rest of the skin, including the suckers, remained intact.

The pupa is coal-black, heavily chitinized, and is shaped like the half of a longitudinally cut egg, though somewhat more flattened. At the anterior end is a pair of dorsal, prothoracic tracheal gills, each gill consisting of four flattened plates. The whole of the flat ventral surface of the pupa is fastened so firmly to the rock that it is practically impossible to remove it without breaking the shell. The length of pupal life is from 16½ to 18 days. If the pupae be taken from the water on the piece of rock to which they are attached, removed to the aquaria, and placed with the heads down stream, under a small stream of water, no difficulty will be experienced in rearing them. A number of specimens reared in this way were observed by the writer to emerge. From five to 15 minutes are required for the imago to free its body from the pupal skin, the wings remaining folded till the abdomen is

free, when suddenly they spread out fanlike and held above the surface of the shallow water, the legs all bunched up and still remaining in the pupal skin. The force of the flowing water and the struggles of the insect in from one to five minutes cause the legs to draw out, and, thus liberated, the imago immediately takes flight. In deeper water the wings probably do not unfold till after the insect is washed to the surface, though no observations were made upon this. Figures of larvae and pupae may be found in Comstock's *Manual*, and in Kellogg's papers in the *Entomological News* for 1900, and in Cal. Ac. Soc. Proc. 1903.

Family SIMULIIDAE

Black flies

In this family the body is short and stout; the legs are short; and the tibiae possess spurs. The antennae are scarcely longer than the head, cylindric and 10 jointed; the two basal joints are differentiated; the others are closely united. Proboscis not elongated, with small horny labella; palpi are four jointed. The thorax is much arched, giving the fly a humpbacked appearance; the scutellum is small; the abdomen is cylindric, composed of seven or eight segments; the legs strong and not elongate. The wings are broad, iridescent, and not clothed with hairs. The veins near the costal border are stout; those on the other parts of the wing are very weak. [*See* pl.34, fig. 1]

The larvae are soft skinned, not slender, usually more or less constricted in the middle. The head is cylindric, with eye spots on each side. The head bears two large fan-shaped organs, which aid in procuring the food. Respiration is accomplished by means of three blood gills which are pushed out from the dorsal surface of the last abdominal segment (Miall & Hammond say from the rectum). On the segment back of the head is a foot armed with hooks, and on the posterior end of the body is a disklike sucker by means of which the larva clings to the rocks or to plants. The creature moves about on the surface of the rocks with a looping gait similar to that of a measuring worm, and a web is secreted which prevents its being washed away by the swiftly flowing water.

The pupae are incased in cocoons which are firmly fixed to the rocks, these cocoons sometimes occurring in dense masses, forming a carpetlike covering on the rocks; in other species they occur separately or in small groups. The pupae, like the larvae, breathe by tracheal gills; but in this stage the gills are borne by the prothorax. The adult fly, on emerging from the pupa skin, rises to the surface of the water and takes flight at once. Soon after this the eggs are laid.

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The life histories of some of the members of this family have long been known. Otto Fabricius in 1784[1] published an article, "Beschreibung der Atlasmücke und ihrer Puppe." A little later (1795) Schönbauer published his account of the immature stages of the Columbacz midge. He was the first to state that these earlier stages are passed in the water. In 1822 appeared Verdat's paper, on S i m u l i u m s e r i c e u m (=S. r e p t a n s, according to Schiner) in which he figures the pupa, the larva, together with enlarged details of the mouth parts of the latter. Among other early writings on life history may be mentioned Fries's

[1] Schr. d. Berl. Ges. naturf. Fr. 5:254–59, tab.3, fig.1–5.

monograph, *Simuliar* (1824), Westwood's *The Water Cress Fly* (1848) and Heeger's *S. columbaschense* (1848). More recently there appeared in proceedings of the Royal Society of Copenhagen (1886) a very useful paper by Fr. Meinert on "De eucephale Myggelarver," of which six or seven pages are devoted to Simulium, besides some very good figures. On the early stages of American species, Riley, in the report of the United States entomologist for 1884, p. 342-43, writes as follows:

The early stages of several of the American species have been studied. In the *American Entomologist* [June 1870, 2:227] under the heading, "The Death Web of a Young Trout" we described the larva and pupa with figures of a species afterward described by us as S i m u l i u m p i s c i c i d i u m [*ibid*, p. 367]. These larvae were said by Seth Green to live attached to stones in swift running water and to spin a silken thread in which young fish became entangled and killed. This statement created much excitement among fish culturists at the time, and really seemed very plausible. It was contradicted, however, by Sara J. McBride, of Mumford N. Y., in an article published in the same volume [p.365-67], and also by Fred Mather of Honeoye Falls N. Y., in private correspondence with us. Mrs McBride found that the perfect flies issued about April 1, and June 1 thereafter the larvae were found in the streams in great numbers—as a general rule attached to water plants 3 or 4 inches below the surface of the water. Some were also attached to stones at the bottom. The majority were fastened to green decaying water cress, and these were green in color, while others which held to dead forest leaves of the previous year's growth, which had become entangled in the cress, were brown. From this fact she justly argued that they fed on decaying vegetable matter. There was a succession of generations or broods throughout the season, the development of a single brood occupying about two months. The flies issuing in midsummer were smaller than those developed in the spring and fall, although no difference in the size of larvae and pupae was perceptible. In the same volume (229–30), Osten Sacken gives an account of an undetermined species found attached to the roots and plants in swift running streams in the vicinity of Washington. This article contains also an able review of previous writings on the subject and is illustrated with figures taken from Verdat. In the *American Entomologist* [Aug. 1880, 3:191–93] Dr W. S. Barnard described the stages, with figures of the eggs, of a common species in the mountain streams around Ithaca N. Y. The eggs

were found on the rocks on the bank a few inches above the surface of the water; the newly hatched larvae were just at the surface, and from this point there was a regular gradation in the size of the larvae down into the stream. The eggs were found abundantly on June 1. In the proceedings of the Boston Society of Natural History for January 1880, Dr Hagen described Simulium pictipes, a remarkably large species, the larvae and pupae of which were found in the rapids of the Ausable river, Adirondack mountains; and in mentioning the fact in the *American Naturalist* for April 1881, we stated that the larvae and pupae of presumably the same species were found by Messrs Hubbard and Schwarz in the rapids of Michipicoten river, north shore of Lake Superior. The larvae were there found to have the peculiarity of floating in long strings, attached to each other by silken threads, while the pupae, found in the quieter pools close by, resembled coral. We also hazarded the statement that these were the immature forms of the celebrated black fly of the Lake Superior region. In reference to the probable identity of the Adirondack with the Lake Superior species, Dr Hagen, in comparison of the specimens of these larvae and pupae, received from Mr Hubbard, with similar stages of S. pictipes, remarked [*Canadian Entomologist*, 13:150–51] that, while the larvae and pupae did not differ materially, imagos from the Lake Superior, not raised from the pupae collected by Mr Hubbard, differed from S. pictipes in the much smaller size and in the color of the legs.

The report of the United States entomologist for 1886 contains detailed account of the life history of two species, the southern buffalo gnat and the turkey gnat. This paper is the most complete record we have of any species of Simulium in this country.

Economic importance. In the northern states the attacks of the black flies on domestic animals, though causing considerable loss to the stock raiser, is not of such a nature that accurate statistics can be obtained. Otto Lugger, late state entomologist of Minnesota, in his report of 1896, p. 201 and 203, says:

The losses caused by this insect are, in some years, very great, and the state of Tennessee alone lost in 1874 as much as $500,000. This southern buffalo gnat occurs as far north as Minneapolis, at least a few specimens have been found there. Here in Minnesota we have a number of other species of this family of flies, which cause more or less injury to our stock.

The first species seen and felt occurs early in the spring, soon after the snow disappears. It is a very small species, which flies with great force so that it can be felt when striking the face. It seems that it does not care much for human blood, but it irritates considerably by being of a very inquisitive nature, even entering the mouth, nose, ear and what is worse, the eye. If horses are left standing for some time in the roads, they are apt to become restive, shake their heads in a violent manner, frequently stamping and snorting at the same time. If the ears of the horse are inspected, we usually find the cause of their irritation in a large number of such small flies, which are busily engaged in sucking the blood, and they do so by inserting their powerful piercing organs into a vein, hence they seem to be arranged in regular rows. If not occuring in very great numbers, they cause but little harm, and an application of a little grease rubbed together with a few drops of carbolic acid, soon remedies the evil, and drives away other intruders. This species flies from May 15 to June 1, and very likely breeds in the Mississippi river near Minneapolis, though the earlier stages have, as yet, not been found. A little later in the season, but chiefly during June and July, a somewhat larger species (*Simulium decorum* Walker) becomes numerous. This species occurs sometimes in large numbers, but only females have been found thus far. This is of course easily explained by the fact that only the females of these flies are bloodthirsty; the males remain near the place of their birth, some running water, and, as they have only a rudimentary mouth, they could not imbibe blood, even if they were inclined to do so. This fly attacks, by preference, cows, and is sometimes found in such large numbers as to cause some injury to them. They are found most usually in the ears, and between the legs, or wherever the skin of the animal is thin and not well protected with hairs. Sometimes the cows suffer severely from their attacks, and, being constantly irritated by these small tormentors, they lose in flesh and give less milk. The front feet are in constant motion, a habit all species have, and are utilized more as feelers than as legs. This species is found active during the whole summer and autumn, but only in certain places, which can however be very far from the breeding places, and these insects must possess some very powerful sense to detect their victims such long distances.

The damage done in the South is described by Riley as follows:

As far as can be learned the damage in Louisiana was but slight prior to 1850; but many animals were killed in 1861, 1862,

1863, 1864 and 1866. In this latter year the parish of Tallulah La. lost over 200 head of mules, and upward of 400 mules and horses were killed within a few days in the parishes of Madison, Tensas, and Concordia, all in the same state. In other states they also did great damage. In 1868 many mules were killed in the lowlands of Davies county, Ky. Although frequently causing more or less trouble and loss, they did not appear again in such overwhelming numbers until 1872, 1873, 1874, 1881, 1882, 1884, 1885 and 1886. In 1872 it was reported that the loss of mules and horses in Crittenden county, Ark., exceeded the loss from all diseases. In 1873 they caused serious injury in many parishes in Louisiana. In 1874 the loss occasioned in one county in southwest Tennessee was estimated at $500,000. The gnats have been especially injurious since the Mississippi floods of 1881, and 1882; in the latter year they were more destructive to stock than ever before, appearing in immense numbers in eastern Kansas, western Tennessee and western Mississippi, and the great destruction of cattle, horses and mules caused by them added greatly to the distress of the inhabitants of these sections of the country caused by unprecedented floods. Many localities along the Mississippi river in Arkansas also suffered severely. In 1884 buffalo gnats appeared again in great numbers and were fully as destructive as in 1882. In Franklin parish, La., within a week of their first appearance, they had caused the death of 300 head of stock. They were equally numerous throughout the whole region infested, and for the first time in the history of the pest they attacked horses and mules on the streets of the cities of Vicksburg and Memphis. No general outbreak took place in 1885, yet gnats appeared in sufficient numbers to kill quite a number of mules in various parishes of Louisiana, especially in Tensas and Franklin. Buffalo gnats appeared again in immense numbers in 1886, and extended throughout the entire lower Mississippi valley, and swarms were even observed and doing damage far away from the region usually invaded. They came very late in the season, and consequently animals were in better condition to withstand their attacks. The damage was great however in many localities where planters had not taken steps to protect their stock. Besides the actual loss by death to their stock, planters lose much valuable time in preparing their fields for the crops. It so happens that the gnats appear at a time when the ground becomes fit to be prepared for cotton, and, as it is very important to give that plant as much time as possible to mature, every day is very valuable in early spring. Planters owning large estates have to use their mules for plowing, notwith-

standing the gnats, while farmers on a small scale can keep their animals in the stable, thus protecting them.[1]

Remedies and preventives

A number of remedies to counteract the poison of the buffalo gnats have been tried, but none of them have been sufficiently tested or have proved uniformly effective. The following applications have been of sufficient use to merit further trial: (1) Rubbing with water of ammonia, and administering internally a mixture of 40 to 50 grains of carbonate of ammonia to 1 pint of whisky, repeating the dose every three or four hours until relieved; (2) continued doses of whisky alone and keeping the animal in a cool and darkened stable; (3) immersion in cold water in running streams. Many cases of death of human beings from the bites of buffalo gnats have been reported, and some of them seem well authenticated. The painfulness of their attacks will certainly put people on their guard, but it would be well for persons in localities subject to their invasion to go prepared with some means of protecting themselves when far from shelter during the season of the year when the flies abound. The adults have so far appeared but little subject to attack from other animals. But few birds have been observed to feed upon them, though for the Southern forms the mocking bird, winter wren, and especially barnyard fowls, after the flies become gorged with blood feed upon them. Dragon flies, Libellulidae and robber flies, Asilidae, have been observed to catch them. The larvae are devoured in large numbers by the smaller fishes, minnows, etc., and probably the carnivorous beetle, bugs and other aquatic insects prey upon them. Dr Howard has observed in Washington the larvae of a species of Hydropsyche feeding upon the larvae of a species common in that locality. The pupae are pretty well protected by the resemblance in color to the objects to which they are fastened and their quiet habits. The eggs would seem to be open to the attacks of fishes, carnivorous beetles, etc., but no positive observations have been made. *Osborn*[2]

Very little can be done to destroy this insect in its earlier stages. The removal of obstructions in the rivers, which cause an acceleration of the motion of the water, would destroy some of their breeding places, but when there are so many this would make but little difference. Any chemicals to kill the larvae and pupae in the water would also kill fish, as they would have to be used very strong. The only way we have to protect ourselves

[1] U. S. Dep't Agric. Rep't. 1886. p.502.
[2] U. S. Dep't Agric. Div. Ent. 1896. Bul. 5, n. s. p.37, 38.

and our animals are repelling substances, such as stinking oils and smudges. A number of repellents are sold, and some of them are very good, for instance the "Black-fly cream," made in Portland Me. Our fishermen and hunters frequently use a mixture of kerosene oil and mutton tallow, with which the exposed parts are greased. For animals any of the strong smelling oils can be used, but repeated applications are apt to hurt them or to remove the hair. Oil of tar is a simple and easily applied wash. To make it, a quantity of coal tar is placed in a large shallow receptacle in which is stirred a small quantity of oil of tar, or oil of turpentine, or any similar material. After filling the receptacle with water it is kept undisturbed for several days, when the animals to be protected are washed with the impregnated water whenever necessary. Smudges are the best as a protection and the animals soon realize their protection and crowd to them for shelter, even refusing to leave them when needed elsewhere. As the black flies are active during the day only, and the mosquitos towards evening and night, dwellers in our northern woods have a bad time of it and sometimes suffer very greatly on their account. It is easy, however, to drive these tormenters from houses or tents. By burning inside of them a little Pyrethrum powder (Persian or Dalmatian insect powder) upon a piece of bark these intruders are either killed or so stupefied that they do not bite for some time. This method is in general use in the houses and stores of the Hudson Bay Company, and the writer has always used it successfully in his numerous trips. The fumes of the burning insect powder are not very offensive, at least not nearly so much so as the poisonous bites of such insects as black flies and mosquitos. *Lugger*[1]

Structural characters

There is but one genus of the family Simuliidae, Simulium, which possesses the characters of the family.

The eggs of the known species are deposited in a compact layer on the surface of rock over which water is flowing in situations as shown on plate 32. Their shape is elongate ellipsoidal, but they are usually closely packed with the long axis vertical and hence assume a polyhedral cross section. Eggs of the different species doubtless vary in size, those of the larger species (e. g. S. pictipes) measuring .40 by .18mm. In

[1] Minn. Agric. Exp. Sta. 1896. Bul. 48, p.207.

Hungary the eggs of S. columbatczense midge have also been studied. When first laid, they are enveloped in a yellowish white slime, which becomes darker, till, finally, it becomes black just before the emerging of the larva; the egg stage lasting about a week. For further notes on the eggs of Simulium see New York State Museum bulletin 47, 1901, page 408.

Larva. The larval stage of the known species lasts about four weeks in the summer, though longer in the cold weather. It is in this stage that it hibernates. Swift flowing water is essential to its life; if removed to quiet water, it dies within a day, and usually in a few hours. Fastened to the rock, twig or leaf by the anal end of the body, it assumes a more or less erect position and moves its head occasionally with a circling motion. It is able to move about on the surface of the rock or sides of the vessel in which it may be placed. Its manner of progression resembles that of the larva of a geometer moth, though not so rapid. Attaching itself by means of its thoracic proleg, it draws up its body in a loop, then, attaching itself by means of its caudal sucker, it releases the hold of its proleg. According to the unpublished observations of Miss R. Phillips (of the class of 1890, Cornell University), the larva feeds on algae, as Nothix, Cladophora, Vaucheria, on diatoms and parts of phanerogamous plants. Sand also has been found in the digestive canal.

Structure of the larva. The full grown larva of even the largest species does not exceed 15mm (about $\frac{5}{8}$ inch) in length. The body is somewhat cylindric in shape, enlarged at both ends, attenuated in the middle, the posterior half much stouter than the anterior part, and almost club-shaped [pl.34, fig.9]. Besides the head there are 12 poorly defined segments, the first two of which consolidate shortly before pupation. The color of the larva varies with the species, and perhaps also, to some extent, with the nature of its food. Some are a deep shining black, with paler incisures; others gray, yellow or dark green; in some the ventral surface is much lighter than the dorsal,

and in most of them the incisures are paler in color. On each side of the thorax is a triangular dark spot in the mature larva which marks the position of the developing tracheal gills of the pupa. The head is nearly quadrangular, a little longer than wide, dark brown or blackish in color, heavily chitinized, with two approximated irregular black eye spots on each side near the lateral margin.

The antennae are placed at the sides of the head toward the cephalic end, dorsad of and near the base of the fan. They are very slender, apparently three jointed, about one half as long as the width of the head. The first joint is twice as long as the others taken together, slender, flattened, and sometimes almost hyaline; cylindric at the articulation with the second. The second joint is very slender, cylindric. The third joint is a short pointed process at the apex of the second; and two similar processes are usually to be seen at the articulation of the first and second. The fans are placed laterally at the cephalic end of the head [pl.34, fig.7]. Each fan consists of from 30 to 60 scythe-shaped rays (variable with the species), ciliate on the inner side, with longer setae at regular intervals [pl.34, fig.7, 8]. Each ray is widened dorsoventrally on about its basal one fourth, and, when spread, presents the appearance of the arc of a circle extending over the width of the fan near the base. The rays of the fan are borne on stout peduncles, to which they are articulated. The fans seem to be used in sweeping food into the mouth of the larva. When closed, the tips of the rays come just to the oral opening. The rays are folded when the larva is disturbed, otherwise widespread. The mandibles are placed ventrad of the fans and move in a horizontal plane. They are elongate, rather stout, brown, nearly twice as long as wide, furnished with teeth on the inner side near the apex, from two to four large, black teeth at the apex, and from six to 15 paler colored teeth behind these, gradually decreasing in size, excepting that the last two are usually stouter and larger than those immediately preceding. The stout apical teeth are difficult to count because, lying in differ-

ent planes and covered by the hair, they are somewhat obscured. The mandible is furnished with a dense fringe of hairs extending over its apex, more or less overhanging the teeth. Near the base on the ventral side (the jaws moving in a horizontal plane) is a fan of hairs which projects mesad, at right angles to the long axis of the mandible. Ventrad and mesad of the mandible are the maxillae. The maxilla with its palpus projecting outwardly is shaped somewhat like a mitten, the palpus representing the thumb [pl.36, fig.2]. Several long fringes of hairs extending cephalad and mesad, cover the surface of the lacinia, among which is a single stout spurlike process. On the palpus are a few scattered bristles, at its base usually a small tuft of hairs, and its apex is provided with papillae. The chitinous labrum is a short, somewhat semicircular shaped piece overhanging the mouth, its plane being nearly perpendicular to the long axis of the larva. Externally it is stiffened by a T or Y shaped brace, the stem forming a longitudinal keel [pl.33, fig.11, and pl.36, fig.5]. Extending apically is a long fringe of hairs, and back of the suture, combed backward and outward, are long hairs. The apical margin is sometimes serrate. The hypopharynx, through which the silk thread passes, is a rather complex structure; it consists primarily of two flattened chitinized plates, connected by membrane, forming a flattened tube [pl.37, fig.2]. At the apical (cephalic) end of this is articulated a complex chitinous doubly arched segment with two fringes of long, coarse hairs. The ventral plate is somewhat quadrangular in shape, widened cephalad, with its anterior and posterior margins concave, and its lateral margins sinuous. On its anterior margin, apically, is a transverse chitinous comb [pl.36, fig.4]. The dorsal plate [pl.37, fig.2] is composed of two triangular pieces joined on the center line. On its apical (cephalic) edge is a transverse comb which projects cephalad and ventrad. This comb lies somewhat cephalad of the comb of the ventral plate. The dotted lines of plate 36, figure 4, mark the position of the dorsal plate. The ducts from the silk glands [pl.37, fig.2] pass up between the two plates, the

threads uniting as they pass between the combs of the dorsal and ventral plates. I believe the function of the upper plate to be a press for the silk thread. On each side, extending dorsad and caudad, is a chitinized, hornlike process. Only the fringe of hairs of the hypopharynx is visible when the larva is viewed from below, the rest being covered by the labium. The suture between the labium and the ventral surface of the head, indistinct in some species, seems entirely wanting in others, and therefore, the labium is immovable. The cephalic margin of the labium is furnished with regularly placed teeth; the arrangement of which, together with the number and arrangement of the setae on the ventral surface, furnishes some excellent specific characters. Since, in order to identify a species, it is necessary to dissect out the mouth parts, a few words in this connection will not be out of place here. If the specimen, either fresh or alcoholic, be placed on its side, and with a scalpel a frontal cut made through the head, passing just below the eye spots separating the dorsal from the ventral surface, then, placing the sections with the cut surface uppermost, the mouth parts may be readily picked out with a needle. In the ventral part will be found the maxillae, the hypopharynx and the labium. The hypopharynx lies very close to the labium and therefore requires some care to remove it. In the dorsal part will be found the fans, the labrum, and the mandibles. If the cut be made too far toward the dorsal surface, the mandibles will be attached to the ventral part, and the labrum will probably be destroyed, since it lies at right angles to the axis of the body, overhanging the mouth opening. The separate parts may then be dehydrated, cleared, and mounted on a glass slide.

The single thoracic proleg attached to the ventral surface of the first (or second?) segment is an elongate, truncate, conical process, at its extremity with a number of rows of hooks, similar to those found at the anal end, to be described later. The use of this proleg has already been mentioned. From a narrow, slitlike opening on the dorsal surface of the last segment of the body are projected the retractile, translucent,

respiratory filaments (blood gills). These are three branched, sometimes simple, often much lobed [pl.37, fig.9]. Caudad of these is a chitinized, X-shaped fold, the anterior branches extending cephalad and laterad for a short distance. At the caudal end, with its plane nearly at right angles to the longitudinal axis of the body, are concentric circles of tiny hooks, the center of the circle being hollowed out, suckerlike. The rows of hooks, though arranged in concentric circles, are also arranged radially, so that about 100 radii may be counted, each radius with from eight to 20 hooks (varying with the species, and perhaps also, with the age). The function of these hooks with the suckerlike disk is for attaching the larva to the rock or rubbish in the water, affording a very firm hold. In some species the circle is not quite complete, but is slightly open on the dorsal side. The larva possesses two silk glands, laterally placed, extending about three fourths the length of the body, then recurved, U-shaped, extending back to the thoracic segments. The outlets are the two ducts which lead into the hypopharynx [pl.37, fig.2]. The silk is used by the larva for attaching itself to the surface on which it rests, to prevent its being washed away by the rapid flowing water and to build its pupal case. According to observations made by Miss Phillips and recorded in her thesis (1890), the spinning of the cocoon of S. pictipes is described as follows:

"In spinning, the thread issues from the mouth and is placed in the different positions by the thoracic proleg. The head is bent down, and with the proleg the thread is drawn around the body and other threads placed or twisted in all directions, until a very irregular network is formed, covering the whole of the body, except the head. The skin of the head is then cast off, and the insect pulls itself out of the skin of the body, leaving it whole. The cast skin may often be found in the cocoon, with the pupa. The cocoons are commenced at the upper margin and spun continuously down to the caudal end, where several threads are drawn from the cocoon and attached to the last one or two of the body segments of the pupa. The threads hold

the pupa very firmly and are always found when the pupa is pulled out of its case. Spinning is rarely seen excepting when the insect is in a stream of running water."

The pupal cases are usually composed of a rough, tough, clothlike fabric, and vary in shape with the different species. Three types of cases are known to me. One is shaped like a shoe, entirely concealing the pupa [pl.35, fig.5]. This is sometimes slightly modified, the heel being less prominent, and the instep disappearing, i. e. shaped like a flattened cylinder, the planes of the bases being parallel, but oblique (S. p i c t i p e s, and in a California species). Another, the most common type, is like that of a wall pocket, the head and the thoracic filaments projecting.[1] The third type is structureless, composed of a matted mass of thread on the rock, sometimes only partly covering the pupa; as in S. h i r t i p e s. Large numbers of pupal cases are frequently found matted together, carpetlike. The pupa are generally of a pale or golden brown color, the abdomen being somewhat darker. The eyes of the adult soon become visible, as also the legs and wing cases. Eight body segments are visible from the dorsal surface, not counting the anal. The respiratory filaments arise from a single stalk on each side; this stalk has a variable number of branches, which again subdivide into twigs. The number of twigs is constant for a given species, ranging from four (in a European species) to upward of 60 in one of our own. For a description of their structure see a paper by Dr Volger, *Die Tracheen Kiemen der Simulien Puppen.*

On the segments are a number of small, regularly arranged black hooks, by which the pupa is attached to the fibers of its case. The arrangement of these hooks appears to be uniform for a given species. The pupal stage lasts about a week, sometimes a little longer. The adult makes its escape from the pupal skin through a longitudinal rent on the dorsum of the

[1] See Riley's figure of pupal case in U. S. Dep't Agric. An. Rep't 1886, of S. m e r i d i o n a l e, or U. S. Dep't Agric. Div. Ent. Bul. 5, n. s. 1896. p.53.

thorax, leaving the skin, together with the respiratory filaments, otherwise intact.

The generic characters of the imagos have already been given in sufficient detail in the characters of the family; to which need only be added that the tarsal claws of the male in all the species I have examined are trifid; those of the female being either simple or bifid. All the tibiae are provided with spurs, in a few species only are those of the fore legs rudimentary. The middle and hind metatarsi possess a more or less regular row of spines on the extensor margin, which are wanting on the fore metatarsi. On the second joint of the hind metatarsus at its articulation with the first, there is usually a leaflike appendage covering the base of the flexor surface [pl.38, fig. 1, 8, 9].

List of the North American species of Simuliidae, genus Simulium

Latreille, Hist. Nat. Crust. et Ins. 1804. 14:294.

[1]***argus** Williston, N. Am. Fauna, no. 7. May 1893. p.253. Cal. (Syn. of S. vittatum Zett. according to Coquillett, Harriman Exp. 1900. p.393).

argyropeza. See reptans.

***bracteatum** Coquillett, U. S. Dep't Agric. Div. Ent. Bul. 10, n. s. 1898. p.69. Mass., Cal., N. Y., Kan., Mich.

calceatum Harris. A catalogue name according to Riley. Am. Ent. 1870. p.467.

cincta. See reptans.

***cinereum** Bellardi, Saggio di ditterologia Messicana. 1:13. Cal. (Townsend, Baja. etc. 1893). Mex. (Bellardi).

columbatchensis Fabricius nec Schönhauer. See reptans.

decorum Walker, List of Dipterous Insects, etc. ptl. 1848. p.112. Hudson Bay Ter. (Syn. of S. vittatum Zetterstedt, according to Coquillett, n. s. Bul. 10, 1898. p.68).

elegans. See reptans.

erythrocephala. See reptans.

***fulvum** Coquillett, U. S. Nat. Museum Proc. 1902. 25:96:
1898 ochraceum Coq. not Walk. Mont.; Id.; Col.; N. M.; Alaska.

***glaucum** Coquillett, U. S. Nat. Museum Proc. 1902. 25:97. Missouri.

***griseum** Coquillett, U. S. Dep't Agric. Div. Ent. Bul. 10, n. s. 1898. p.69. Col.

***hirtipes** Fries, Obs. Entomol. Pars, Monogr. Simuliar. 1824. p.17, 5. Tfl. 1, f.1. N. Y., Id., Cal.
The following synonymy is according to Schiner:
1830 rufipes Meigen, Syst. Beschr. 6:311-17.
1830 hirtipes Fries, Meigen, Syst. Bescher. 6:312-18.
1850 hirtipes Fries, Zetterstedt, Dipt. Scand. 9:3426-28.

[1]Those names to which a * is prefixed I consider either a distinct species, or not sufficiently described to warrant placing as the synonym of another.

innoxium Comstock. See S. pictipes Hagen.

***invenustum** Walker, List of Dipterous Insects, etc. 1848. p.112. Hudson Bay Ter.

(pecuarum Riley is a synonym of this, according to Coquillett, 1898).

***irritatum** Lugger. Figured but not described in Univ. Minn. Agric. Exp. Sta. Bul. 1896. p.203.

***meridionale** Riley, Dep't Agric. An. Rep't for 1886. 1887. p.512.

1891 occidentale Townsend. Psyche, July 1891. p.107. Mass., Miss., Neb., Tex. (synonymy and localities according to Coquillett, Bul. 10, n. s. 1898), N. J. (Johnson), Kans. and Id.

***metallicum** Bellardi, Saggio di ditterologia Messicana. 1859. 1:14. Mex.

***mexicanum** Bellardi, Saggio di ditterologia Messicana, Appendix 6. 1862. Mex.

minutum Lugger, Minn. Agric. Exp. Sta. Bul. 1896. p.202. Minn. (Figured but not described). See vittatum.

molestum Harris. See venustum.

novicum Harris, Ins. Inj. to Veg. p.601. This is a Ceratopogon.

occidentale Townsend. See meridionale.

***ochraceum** Walker, Ent. Soc. London. Trans. n. s. 3:332. Mex.

***pecuarum** Riley (Synonym of invenustum according to Coquillett).

1887 pecuarum Riley, U. S. Dep't Agric. Rep't for 1886. p.512. N. H., N. Y., Mass., Ct., D. C., Mich., Miss., La. (synonymy and localities according to Coquillett, U. S. Dep't Agric. Bul. 10, n. s. 1898), N. J. (Johnson).

***pictipes** Hagen, Bost. Soc. Nat. Hist. Proc. 1880. 20:305.

N. Y., Tex., Cal. (Coquillett, 1898) Id.

1895 innoxium Comstock. Name given in Manual for the Study of Insects.

piscicidium Riley. See venustum.

posticata Meigen. See reptans.

***pulchrum** Philippi, Chilian Diptera. 1865. p.633. S. Am. and St Vincent, W. I.

1896 tarsale Williston, Diptera of St Vincent, W. I. p.268. Synonymy according to Hunter, Catalogue of S. Am. Diptera. 1900.

***quadrivittatum** Loew, Berl. Ent. Zeit. 1862. Centur. 2, p.2. Cuba.

***reptans** Linnaeus, Fauna Suec. 1893. Europe, Greenland (Lundbeck, 1898). 1761.

Synonymy according to Schiner:

1767 sericea Linnaeus, Syst. Nat. 12:978, 58
1776 erythrocephala DeGeer, Ins. 6:161, 37 (Tipula)
1781 reptans L. Schrank, Enum. Ins. Austr, p.985 (Culex)
1787 colombatchensis Fabricius, Mantissa Ins. 2:333 (Rhagio)
1804 argyropeza Meigen, Classif. 1:96
1818 reptans Meigen, Syst. Beschr. 1:291-92
1818 sericea Meigen, Syst. Beschr. 1:296-98
1818 elegans Meigen, Syst. Beschr. 1:296-99
1818 variegata Meigen, Syst. Beschr. 1:292-93
1823 reptans Fries, Obs. Entomol. Pars 1 Monogr. Simuliar, p.13
1830 cincta Meigen, Syst. Beschr. 6:311, 14
1838 posticata Meigen, Syst. Beschr. 7:52, 21

rufipes Meigen. See h i r t i p e s.
sericea Linnaeus. See r e p t a n s.
***tamaulipense** Townsend, N. Y. Ent. Soc. Jour. 1898. v.7. Tex.
tarsale Williston. See p u l c h r u m Phillipi.
tribulatum Lugger, Minn. Agric. Exp. Sta. Rep't 1896. p.205–7. Probably equals v i t t a t u m. (p.385. Seq.)
(Figured but not described)
***venustum** Say, Acad. Nat. Sci. Phil. Jour. 3:28; Compl. Wr. 2:51
Wiedemann, Auss. zw. Ins. 1:71. Ohio, D. C. (Osten Sacken, catalogue). N. J. (Johnson); Can., N. H., N. Y., Mich., Minn., Wyo., B. C., Cal., Tex., La., Miss., Fla., (Coquillett); Id. The following synonymy is according to Coquillett. 1898.
1862 m o l e s t u m Harris, Ins. Inj. to Vegetation. (Not described)
1870 p i s c i c i d i u m Riley, Am. Ent. 2:367. Mumford N. Y.
***virgatum** Coquillett, U. S. Nat. Mus. Proc. 1902. 25:97. New Mexico.
***vittatum** Zetterstedt, Ins. Lapponica. 1840. p.803. Staeger Groenl. Antl. Greenland (Osten Sacken's catalogue); N. J. (Johnson); Alas. (Coquillett 1900); Cal., Kan., Minn., N. Y., Neb. (Coquillett 1898), Id., S. Dak. The following synonymy according to Coquillett.
1848 d e c o r u m Walker, List. Ins. p.112. Hudson Bay Ter.
1893 a r g u s Williston, N. Am. Fauna, no. 7, p.253. Cal.

KEY TO SPECIES OF SIMULIUM

Larvae

1 Mature larva 6 or 7mm long, with the dorsal surface of the head nearly white; the rays of the fan number about 30. Larva from Santa Cruz mountains, Cal. [p.387].
Head usually brown; rays of the fan usually 40 or more.....(2)
2 The top of the head with six black blotches or spots. Larvae from New Mexico [p.386].
Head without six dark spots.....(3)
3 The caudal blood gills are three simple papillae.....(4)
The three main branches are again subdivided.....(6)
4 The middle tooth of the labium is simple and pointed, labium with six pairs of setae on its ventral surface [pl.35, fig.2].v i t t a t u m
The middle tooth at least is trifid.....(5)
5 All marginal teeth of the labium except the outer pair are trifid .....h i r t i p e s
The middle tooth only is trifid; ventral surface with three pairs of setae [pl.33, fig.8].....p e c u a r u m (i n v e n u s t u m)
6 Full grown larvae 10-12mm in length, black in color, its labium with an elongate middle tooth [pl.36, fig.3].....p i c t i p e s
Paler larvae less than 10mm in length.....(7)
7 No setae on the last joint of the maxillary palpus, middle tooth of the labium longer than the two lateral ones, four pairs of setae on its ventral surface. The pair of apical setae of the mandible not differentiated from the hairs which overhang the apex.....m e r i d i o n a l e

Mandible with a pair of apical bristles, palpus of the maxilla with setae ..... (8)

8 Middle tooth of the labium enlarged, ventral surface of labium with five pairs of setae [pl.37, fig.6] ..... venustum

Middle tooth not enlarged (varieties of venustum) ..... (9)

9 Labium with four pairs of ventral setae [pl.37, fig.14] ..... var. a

With seven pairs of setae [fig.5] ..... var. piscicidium

Pupae

(Arranged according to the number of filaments in each respiratory tuft)

1 With six filaments

a Legs in their cases appear bicolored[1] ..... venustum

b Legs unicolored ..... meridionale

2 With eight filaments

a Pupa 4.5mm long; Arizona species. Pupa described in Am. Ent. Soc. Trans. p.45. 1893.

b Less than 4mm long; eastern species ..... venustum, var. piscicidium

3 With nine filaments. Pupal case like that on pl.35, fig.5 ... pictipes

4 With 10 filaments ..... var. a of venustum

5 With 12 filaments. Pupal case [pl.35, fig.5]. From Santa Cruz mountains, Cal. [p.387]

6 With 16 filaments ..... vittatum

7 With 24 to 48 filaments [pl.33, fig.10] ..... pecuarum

8 With 60 or more filaments ..... hirtipes

Imagines

1 Ground color of the thorax and abdomen deep yellow ..... (2)

Gray or black; its hairs may be pale ..... (3)

2 "Femora with black tip, length of fly 2mm." Mexico .. ochraceum

"Femora without black tips. Length 3 to 4.5mm. Rocky mountains" ..... fulvum

3 Hind tarsi with its basal joint partly yellow; legs bicolored ..... (9)

Hind tarsi unicolored[2] ..... (4)

4 Halteres dusky; thorax not striped ..... (5)

Halteres white or yellow; the female with striped thorax and bifid tarsal claws ..... (6)

5 Body black; the female with dense yellow pile, her tarsal claws simple; the male with dense hair on the legs, his tarsal claws trifid. The wing with its radius three branched. Length 3 to 4.5mm ..... hirtipes

"Body gray, legs reddish gray, feet black; length 3mm." This is said by Mr Coquillett to be the same as pecuarum Riley ..... invenustum

6 Males, eyes contiguous ..... (7)

Females, eyes separated by a distinct line ..... (8)

[1] In order to see this it will be necessary to examine nearly mature specimens and perhaps to draw them from their pupal skins.

[2] The male of pictipes sometimes has legs nearly unicolored; it is however included in the preceding section.

7 Thorax velvety black; legs reddish with black tarsi. Length 1.5 to 2mm. Compare here also bracteatum (male), "with legs wholly brown."..... meridionale
Thorax brownish black; legs usually pale; tip of tarsi not black. Length from 2 to 4mm..... pecuarum
8 Thorax with silvery white pubescence; legs brownish black, covered with whitish hairs. A small variety (less than 2mm long), from New Mexico has been named occidentale Town. (q. v.)..... meridionale
Thorax with yellow hairs; legs reddish brown, covered with yellow hair; tip of tarsi blackish..... pecuarum
9 Males, eyes contiguous..... (10)
Females, eyes separated..... (20)
10 "Mesonotum wholly velvet black; gray spot on sides of the second, fifth, sixth, and seventh segments of abdomen. Length 1.5mm." ..... bracteatum
Metanotum striped, or with grayish or metallic reflections..... (11)
11 Dorsum of thorax with one or more longitudinal stripes..... (12)
Dorsum unstriped ..... (14)
12 Thorax with four longitudinal stripes; posterior margin white; abdomen black. Sex not given. Cuban species.... quadrivittatum
Thorax not so marked..... (13)
13 Front and middle femora and tibiae wholly yellow; center of mesonotum with a black vitta, elsewhere gray. Length 1.5mm. Colorado species ..... griseum
Femora and tibiae wholly or partly brown..... (13a)
13a "Femora and front tibiae yellow, their apices brown; middle tibiae brown, a yellow ring beyond the base, hind tibiae brown, the extreme base yellowish. Mesonotum marked with a narrow median and laterally with a very broad velvet black fascia." Length 3mm. New Mexico..... virgatum
Front femora brown, tibiae brown on apical part..... (13b)
13b Mesonotum with two narrow gray stripes (sometimes quite indistinct) on a velvet black ground, in which there are scattered golden hairs..... vittatum
"Mesonotum marked with a narrow median and slightly wider lateral black vittae." Length 2.5mm. Missouri..glaucum
14 Anterior femora yellow. Mexican species..... (15)
Anterior femora black..... (17)
15 Abdomen with the base of the second segment, and the sides of the third, fourth, and fifth yellowish white; tibiae fuscous black with yellow bases. Length 4mm..... mexicanum
Abdomen black ..... (16)
16 Metallic bluish black species; middle portion of fore tibiae, base of middle and hind tibiae, base of first and second joints of middle and hind tarsi, whitish. Length 2mm... metallicum
Thorax fuscous and cinereous pollinose; the humeri pallid, fore coxae pale, middle and hind ones dark; femora pale at the base, black at the tip; tibiae black. Length 3mm..cinereum

17 An oblique metallic streak extending inward from each humerus; posterior part of the thorax metallic. Length 2 to 2.5mm.....venustum
Humeral spots not metallic.....(18)
18 Anterior coxae yellow; long hair on femora and hind tibiae; thorax velvet black with white pruinose margin (Greenland).....reptans
Anterior coxae black.....(19)
19 Thorax velvet black, with oblique cinereous humeral spots, and usually two tiny metallic spots between them. Length 3 to 4mm.....pictipes
Thorax velvety black with two very narrow gray stripes and posterior margin; hind tibiae usually yellow at the base, hair on legs sparse.....vittatum
20 Thorax striped.....(21)
Thorax without stripes.....(25)
21 Dorsum of thorax with four longitudinal lines, posterior margin, white pollinose; abdomen opaque black. Cuban species.....quadrivittatum
Not with four stripes.....(22)
22 Dorsum of the thorax with five stripes, the outer ones spot-like, the intermediate ones clubbed at the ends; abdomen with black fascia on each segment, produced posteriorly at the middle and the ends. Sometimes the last few segments have only three or five spots.....vittatum
Thorax with one or three stripes.....(23)
23 With three stripes.....(24)
"With an indication of a darker median vitta" [*see* 31]....griseum
24 Small species, length about 1.5mm. "Abdomen silvery, third and fourth segments wholly brownish, sometimes with a median spot on each; legs yellowish, tarsi blackish or brownish." Species from Texas.....tamaulipense
Larger species 3mm. or more in length.....(24a)
24a Middle tibiae brown with a yellow ring beyond the base; vittae of mesonotum brownish, the median vitta dilated posteriorly, wider than either of the lateral ones. New Mexico.....virgatum
Femora and tibiae grayish, sometimes quite pale, tips of tibiae black. Laterodorsal thoracic stripes clubbed at the anterior end. Third, fourth, fifth, and part of sixth and seventh abdominal segments with velvet black fasciae; center of 6, 7, and 8, grayish or dull brown.....pictipes
25 Abdomen without distinct black spots.....(26)
Abdomen spotted.....(31)
26 Abdomen black, covered with long yellow pile; legs yellow, the tips of the femora and tibiae, and all the tarsi except basal two thirds of the hind metatarsi, brown.....bracteatum
Abdomen nearly bare.....(27)
27 Body gray or cinereous.....(28)
Body brown or black.....(29)

28 "Body gray with a white milky luster, specially the pleura and pectus. Legs tawny, femora and tibiae with irregular piceous bands, tarsi piceous. Length 2.5mm. Hudson Bay Ter." This is a synonym of vittatum Zett. according to Mr Coquillett (1898).....decorum

Thorax fuscous or cinereous pollinose, humeri pallid, pleura pale cinereous, scutellum pale at the tip; abdomen blackish; fore coxae pale, middle and hind ones cinereous; femora pale at the base, black at tip; tibiae black. Length 3mm. Mexican species.....cinereum

29 Abdomen somewhat shining, yellowish gray or whitish at the sides, and yellow at the base; legs brown, tibiae and fore coxae white, tip of tibiae and all tarsi black. European species, also occurring in Greenland.....reptans

Basal segments of abdomen opaque, distal four segments somewhat shining black or brown. Two long hairs at the tip of the first and third fore tarsal joints.....(30)

30 Legs reddish yellow, tarsi black, except proximal half of middle and hind metatarsi which are light yellow. Length 2mm. (St Vincent island) This is a synonym of pulchrum Phil. according to Hunter.....tarsale

Legs black, base of tibiae, first joint of middle and hind tarsi and sometimes base of femora yellow; extensor surface of all the tibiae more or less whitish. A widely distributed and variable species.....venustum

31 Length 1.5mm. Front and middle femora and tibiae wholly yellow; hind ones, except apices, also yellow. (Colorado).griseum

Length 2.5mm. Legs brownish black, distal part of femora, base of tibia, and greater part of metatarsi light yellow. (California).....argus

Some of the characters used in this table have been taken from the key given in United States Department of Agriculture, division of entomology, bulletin 10, new series, 1898, page 68, by Mr Coquillett. In the table given above, I have included all the North American species. For the southwestern and Mexican species it should however be used with caution as I did not have specimens of some of these.

Descriptions of the species

S. argus Williston

N. Am. Fauna, No. 7. May 1893. p.253. Cal. (Syn. of S. vittatum Zett. according to Coquillett, Harriman Exp. 1900. p.393)

Female. Black, the legs in part light yellow; front black, opaque; face cinereous, with whitish pubescence; antennae brownish black, the basal joint yellowish; thorax black, the

dorsum thinly pollinose; not shining; pleura densely white pollinose with a black spot; abdomen opaque velvety black, the first three segments with a narrow silvery white spot on either side at the hind margin, the next three segments similarly marked, but the interval between the spots successively wider, and each with two other, successively larger, white spots, leaving a black space in the middle and a narrower one at the outer sides; venter white; legs brownish black, the distal part of the femora, base of tibiae, and the greater part of metatarsi light yellow; wings pure hyaline, the veins light colored, those posteriorly very delicate. Length 2.5mm.

One specimen, Argus mountains, Cal. May 1891.

[1]Coquillett makes this a synonym of v i t t a t u m Zett., though nothing is said above of the handsomely marked thorax so conspicuous in the female of v i t t a t u m.

S. bracteatum Coquillett

Dep't Agric. Div. Ent. Bul. 10, n. s. 1898. p.69. Mass., Cal., N. Y., Kan., Mich.

Female. Dorsum of abdomen deep black, not marked with gray, quite densely clothed with nearly erect yellowish tomentum; mesonotum also deep black and covered with appressed golden yellow tomentum; pleura grayish black; legs nearly bare, yellow, apexes of femora and of tibiae, and whole of tarsi except the basal five sixths of the first joint of the hind ones on brown; first joint of front tarsi scarcely dilated, the first joint of the hind ones one half as wide as their tibiae; head gray, covered with a pale yellow tomentum; antennae black, the two basal joints yellow, mouth parts black; wings hyaline, costal, first three veins and first section of the fourth, yellow, the remainder subhyaline. Length 1.5mm.

Cambridge Mass. (May 31, 1889) and Los Angeles county, Cal. Two females, the one from California captured by the writer.

Male. Mesonotum wholly velvet black; abdomen with a gray spot on the sides of the second, fifth, sixth and seventh segments; legs almost wholly brown, otherwise as in the female. Two male specimens taken with the female.

Some female specimens believed to be this species received from Professor Aldrich, and a single specimen caught on a window in Ithaca, Oct. 16, by the writer agree perfectly with Mr Coquillett's description excepting that the abdomen of these

[1]Wash. Acad. Sci. "Harriman Exp." 1900. p.393.

specimens has two longitudinal rows of small spots which are not covered by the yellow tomentum. This was particularly noticeable in the fresh specimen, but, as drying caused shrinkage of the abdomen, the spots are no longer so distinct.

The fore tibiae are each provided with a single spur, the middle and hind ones each with a pair. The tarsal claws are each provided with a large basal tooth or lobe [pl.38, fig.15]. The halteres are pale yellow.

Cambridge Mass. and Los Angeles Cal. (Coquillett, 1898); Lawrence Kan. and Battle Creek Mich. (Collected by Professor Aldrich); Ithaca N. Y.

S. cinereum Bellardi

Saggio di ditterologia Messiana. 1859. 1:13

Male and female. Gray, antennae black, first joint pale. Thorax fuscous and gray pollinose, the humeri pale; pleura light gray; scutellum pale at the tip; halteres white. Abdomen blackish. The front coxae pale, the middle and hind pair grayish brown; the femora pale at the base, their tips black; tibiae black, their middle section pale; front tarsi wholly black, the middle and hind pair with the bases of first and second joints pale. Wings hyaline. Length of body 3mm; with extended wings 9mm.

Mexico, California (Townsend, 1893).

S. decorum Walker

List of Diptera. Brit. Mus. 1848. p.112

Cinereum, argenteo micans, antennis piceis, pedibus fulvis, femoribus tibiisque picco fasciatis, tibiis posticis tarsisque posterioribus basi albis, alis limpidis. Body gray, adorned with white milky luster, specially on the sides of the chest and on the breast; feelers piceous; legs tawny; thighs and shanks with irregular piceous bands; feet piceous; fore thighs adorned with white luster; hind shanks and four hinder feet white at the base; wings colorless; fore border veins pale tawny; the other veins still paler and very indistinct; poisers pale yellow. Length of the body 2.5mm; of the wings 6.5mm.

St Martin's falls, Albany river, Hudson bay. Presented by Mr G. Barnston.

According to Mr Coquillett,[1] decorum is a synonym of S. vittatum Zett.

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[1] U. S. Dep't Agric. Bul. 10, n. s. 1898.

In the report of the Minnesota Experiment Station, Bulletin 48, 1896, page 202, is given a figure of a female fly which is said to be S. decorum. In this figure the thorax is represented as unicolored, the abdomen with the anterior half of the second segment, a semicircular spot on the anterior margin of the segments 3, 4 and 5, a blotch on the sixth, and all of the remaining segments dark; legs dark, excepting the middle section of all the tibiae, a part of the middle and hind femora, and the basal two thirds of the hind metatarsi. No description is given, but the author stated that this fly occurs in large numbers in Minnesota during June and July. Some specimens kindly lent by Mr Washburn from the Minnesota Experiment Station Collection, bearing the label S. decorum proved to be S. vittatum (♀).

S. fulvum Coquillett

U. S. Nat. Mus. Proc. 25:96

Eight female specimens received from Professor Aldrich of Moscow Id. which I have examined, agree pretty well with Walker's description of ochraceum, excepting that in no case is there a trace of black at tip of femora, the tarsi are only slightly darker than the tibiae, and not black, and the length, which according to Walker is 2mm, is nearly double that in these specimens. The description of the Idaho specimens is as follows:

Deep yellow or ochraceous; the head, upper surface of antennae particularly at the incisures and the two basal joints, the mouth parts, sides of thorax at the base of the wing, the abdomen except the basal segments the tips of the tibiae and all the tarsi, particularly the fore and middle pair, and their flexor surfaces, and the hind metatarsi, more dusky than elsewhere. In fact, in some specimens the tarsi and the abdomen may be described as blackish. The head, dorsum of thorax and abdomen are covered with short, sparse, pale yellowish pile. Legs are without long hair; all tibiae with spurs; the tarsal claws simple. Halteres dusky yellow. Wings hyaline, slightly blackish at tip, subcostal cell yellow, the veins yellow except the apical half of the veins of the anterior margin, which are blackish. A yellow cloud follows the course of the media and the anal veins, as in pl.34, fig.1, of hirtipes. Venation as in hirtipes, the vein R_{2+3} being present; but M_{1+2} bends down into cell M_{1+2} slightly more than in the wing just mentioned. Length 3.5 to 4mm. Length of one wing 5mm. Ac-

cording to Mr Coquillett the species also occurs in Colorado and Montana [pl.38, fig.21].

Moscow Id. (June 19).

S. glaucum Coquillett

U. S. Nat. Mus. Proc. 1902. 25:97

Male. Head and body black, face gray pruinose, thorax bluish gray pruinose, mesonotum marked with a narrow median and slightly wider lateral black vittae, broad lateral margins, when viewed from behind silvery white, a pair of large subquadrate spots on the front end separated by the median black vitta, which is here greatly dilated; abdomen velvet black, sides of segments two and five to nine silvery, middle of dorsum of four also silvery; venter almost wholly silvery; femora and tibiae brown, bases of tibiae yellow, anterior side of front ones largely silvery; tarsi black, broad base of first joint of the middle and hind ones whitish; wings hyaline, veins along the costa yellowish brown, the others nearly hyaline; halteres yellow; length, 2.5mm.

In April. Kansas City, Missouri.

S. griseum Coquillett

Dep't Agric. Div. Ent. Bul. 10, n. s. 1898. p.69. Colorado

Female. Front and middle femora and tibiae wholly yellow, hind ones except their apexes also yellow, tarsi brown, bases of the first two joints of the middle and hind ones yellow; mesonotum grayish, indications of a darker median vitta, the sides and front corners yellow, pleura light gray, scutellum yellow; abdomen gray, segments 2 to 6 each marked with three velvet-black spots; wings hyaline, the costa, first three veins, and first section of the fourth, yellow, the others subhyaline; face and front light gray, antennae brown, the two basal joints yellow, palpi black, proboscis yellowish. Length 1.5mm. Colorado. Three females, collected by Mr Carl F. Baker.

Male. Center of mesonotum with a narrow black vitta, mesonotum elsewhere gray, dorsum of abdomen velvet-black, the second and seventh segments and a spot on the sides of the eighth, silvery gray, otherwise as in the female. A male taken with the female specimens.

S. hirtipes Fries

Obs. entomol. Pars 1. Monogr. Simuliar. 1824. 17;5, Tfl. 1, f.1.
1830 **rufipes** Meigen, Syst. Beschr. 6:311-17
1830 **hirtipes** Fries, Meigen, Syst. Beschr. 6:312-18
1850 **hirtipes** Fries, Zetterstedt, Dipt. Scand. 9:3426-28

Male. Black. Eyes contiguous, upper facets larger than the lower; antennae brownish black, including the two rather elongate basal joints, sparsely covered with short grayish white pile; palpi black, hairy, four jointed, the second joint rather wide and flattened. Thorax black, unstriped, the dorsum sparsely covered with an appressed, golden yellow pile, mixed with some black hairs; the scutellum black, with a tuft of long, nearly erect yellow hairs on each side; metanotum black, nearly bare; pleurae brownish black, bare and subshining.

Abdomen black, the basal half of each segment velvet-black, the apical half of each segment (sometimes only the margin) subshining, brownish black, everywhere thinly covered with an appressed pile of yellowish brown and black hairs, the yellow hairs visible only in certain lights, so that both thorax and abdomen appear black. On each side on the leaflike posterior margin of the first abdominal segment is a fringe of long, dark brown hairs. Legs brown to brownish black, including the coxae; the tarsi are usually slightly darker; anterior tibiae with one spur, middle and hind tibiae each with a pair; the legs, particularly the posterior ones, densely covered with pale brown or yellowish hairs, posterior metatarsi as long as the following four joints taken together, wider than the tibia, flattened laterally; all tarsal claws tridentate. Halteres entirely black. Wings brownish yellow tinged, and usually both branches of media, and the first and second anal veins brown clouded. This is most apparent in a balsam-mounted wing. The radius is three branched [see figure]. Length of dried specimens 3.5 to 4.5mm.

Female. Black, everywhere thickly covered with golden yellow, appressed pile, so that the fly appears somewhat yellowish. Eyes separated, the front black with appressed yellow pile; antennae brownish black, the first two joints paler, sparsely covered with short, appressed pale yellow pile, and a few scattered black hairs; palpi dark brown, the mouth parts reddish brown with black tips. Dorsum of thorax black, unstriped, thickly covered with golden yellow, appressed pile; scutellum black, with a tuft of long, nearly erect yellow hairs at the sides, metanotum subshining, brownish black, bare; pleurae brownish black, bare, and subshining. Abdomen black, when viewed from behind the posterior margins of the segments often appear yellowish white; wholly covered with yellow appressed pile. On the sides of the leaflike, posterior margin of the first abdominal segment is a fringe of long yellow hairs. The coxae are black; legs yellow, the knees, the tips of the tibiae and all the tarsal joints slightly darker, the anterior tarsi specially, sometimes brown; hind metatarsi elongate and flattened, though not so

wide as in the male. Anterior tibiae each with one spur, middle and hind tibiae each with a pair. The tarsal claws are simple; wings as in the male, though the media and anal veins are unaccompanied by the brownish cloud. Halteres fuscous, peduncle slightly paler. Length of dried specimens 3.5 to 4.5mm; wing, 3.5 to 4.5mm.

Described from many bred and captured specimens, from Coy glen, Ithaca N. Y., May 1901, and Adirondack mountains, June 1901, Moscow, Spaulding and Peck, Id.; from Professor Aldrich.

I have compared this with European specimens, and find that they agree in every particular excepting that the foreign specimens I have are a little smaller. A number of female specimens collected by Messrs McGillivray and Houghton on Mt Seward in the Adirondacks, agree perfectly even in size with those from Europe. According to the testimony of the gentlemen named, these flies are most persistent biters. Those found around Ithaca are known to annoy horses, and also have been caught biting human beings.

Larvae. In this State they are found in the latter part of April and the first two weeks of May; most of them pupating before the middle of May; the adults appearing eight or nine days after pupation. Some adults appear as early as May 1. The head of the larva is quadrangular, of a rich brown color, the posterior margin nearly black, with a black, divided eye spot on each side. The antennae are slender, first joint occupies about two thirds the whole length, the third joint being pointed, and but little longer than wide [pl. 34, fig. 5]. The fans have 30 to 50 scythe-shaped rays, each with a row of fine cilia on the inner side, at regular intervals with a longer and stouter seta [pl. 34, fig. 8]. The mandibles are stout, with the usual teeth, the apical ones being black, the others paler. The large one most remote from the apex is not so differentiated as with other species. The pair of apical bristles is partly hidden by the hair at apex. The maxillae are wider than long; the palpus being only about twice as long as broad. At the base of the palpus is a tuft of fine setae, and covering it are a few slender bristles [pl.34, fig.3]. The labium has seven apical teeth, all but the outer ones being trifid; on its ventral surface are two rows of five bristles each [pl.34, fig.4]. The labium and hypopharynx as in the other species. The dorsal surface of the thoracic segments is of a dirty yellow color, the ventral surface is nearly

white. On each side is a triangular shaped spot which marks the position of the future respiratory filaments of the pupa. The basal half of the thoracic proleg is fuscous, its apex paler. Extending from the base of the proleg to the first abdominal segment is a broad, dark line with sinous margins. The abdomen is fuscous, paler at the sutures and on the ventral surface. The underside of the last two or three segments is nearly white. The hooks (about 100 rows, 12 in a row) forming the margin of the sucker are dark brown [pl.34, fig.11–12]. In some specimens a fine fuscous line extends the whole length of the ventral surface on the median line. Just before pupation the developing ventral hooks of the pupa become visible. Though retracted in nearly all the material studied, I have found that the blood gills of the last abdominal segment consist of three unbranched lobes.

Pupa [pl.34, fig.10]. Rich brown in color; the two tufts of thoracic respiratory filaments (one tuft on each side) are each divided primarily near the base into four main branches, the two inner ones larger than the outer ones, each branch again dividing two or three times into twigs, so that upward of 60 filaments may be counted. On the ventral surface close to the posterior margin of the last six abdominal segments are four larger upward curved spines; on the dorsal surface near the base of each abdominal segment is a close row of spines projecting caudad, and on the dorsal and lateral surface of these segments, a short distance from the margin, is a row of fine spines projecting cephalad. The last named are not quite so close to the margin, nor are they nearly as large. In the figure the segments are contracted, and the caudad projecting spines appear to be attached to the posterior margin, whereas they belong to the middle of the dorsal surface of the following segment. At the apex of the last segment are two stout hooks projecting dorsad and cephalad. The pupal cases consist of a dark matted mass of silk, of no definite form, secreted on the rock, and in which the pupae are partially imbedded. The pupal life lasts about eight or nine days.

From Professor Kellogg (Leland Stanford Jr University, Cal.) I received specimens of larvae and pupae which agree very closely with those just described. These specimens (collected on the university campus) appear to differ only in that the labium of the larvae possesses but three bristles in each row on the ventral surface. Specimens from Professor Aldrich (Idaho) are identical with those from New York State.

S. invenustum Walker

List of Diptera. Brit. Mus. 1848

Nigrum, cinereo subfuscum, abdomine basi fulvo hirto, antennis piceis, pedibus fulvis, alis limpidis. Fem.: *Cinereum, antennis nigris, pedibus rufo-cinereis, tarsis nigris.*

Body black, overspread with a grayish bloom; base of the abdomen clothed with tawny hairs; feelers piceous; legs tawny and clothed with tawny hairs; wings colorless; fore border veins brown; the other veins tawny and slender; poisers piceous. Female. Body gray; feelers black; legs reddish gray; feet black.

Length of the body 3mm; of the wings 7mm.

St Martin's falls, Albany river, Hudson bay. Presented by Mr G. Barnston. This is said by Mr D. W. Coquillett to be the species which C. V. Riley called p e c u a r u m

S. irritatum Lugger

Minn. Agric. Exp. Sta. Bul. 48. 1896. p.204

Figures are given of both male and female in the bulletin, but without description. Neither is its life history given, though it was apparently known to Mr Lugger. Both the male and female are represented with an unstriped thorax, a fasciate abdomen, and bicolored legs. The male appears to have a light spot on the anterior margin of each segment of the abdomen and a pair of spots on the anterior margin of the thorax. This species is said to be the most common black fly in the central part of Minnesota.

It is to be hoped that this species may again be found and fully described in the near future.

S. metallicum Bellardi

Saggio, etc. 1859. 1:14

Male. Metallic blue black. The base of the antennae, the halteres, the fore femora, the middle portions of the fore tibiae, the bases of the middle and hind tibiae, the bases of the first and second joints of the middle and hind tarsi, are white. Wings hyaline; its veins rather indistinct. Length of body 2mm; extended wings 5mm. Mexico.

S. meridionale Riley

Dep't Agric. An. Rep't for 1886. 1887. p.512 (turkey gnat) 1891; S. o c c i d e n t a l e Townsend, Psyche, July 1891, p.107 (synonymy according to Coquillett).

Female. Length 2.5mm to 3mm. Head uniform slate blue, verging to greenish, or cerulean blue in some lights, clothed with silvery pubescence, which becomes longer behind the eyes; parts below the antennae and trophi more densely pubescent, producing the effect of a white face; eyes with a metallic coppery luster; antennae black with very dense white pubescence; no bristles on basal two joints, which are but very slightly tinged with red; joint 1 shortest; joints 2, 4, and 11, subequal in length; joint 3 widest; joints 4 to 9 subequal in length; joint 10 but slightly shorter than joint 11, which is fusiform; joints 3 to 11 gradually decreasing in width. Maxillary palpi as long as antennae, blackish, with long, whitish bristles. Thorax slate-blue, with less dense, silvery white pubescence; markings quite distinct, producing the effect of a sculpture, and consisting of three black longitudinal lines, the median narrow, widening a little at the apex, and the outer one curving inward at base, and outward at apex, sometimes reaching to base of patagium, which appears whitish on account of the dense pubescence; on the lateral edges of prothorax are fine black sutures; underside uniform slate-blue, with sparse pubescence; space around the large stigma almost white. Halteres white, very faintly tinged with red. Abdomen nine jointed, joints subequal in length, except the last two, which decrease; markings entirely different from those of S. *pecuarum*, formed by velvety black, dark blue and bluish white, almost silvery, colors; the dark blue appears on dorsal surface of the last five segments, spreading from a roundish median spot, on 5 to the immaculate blue of the last two segments; segments 2, 3, and 4 have each a black cross-bar, and 5, 6, and 7, two narrow, black submedian stripes, which disappear almost entirely on 7; the bluish white forms an outer edge to all the black and extends over the whole lower surface of the abdomen, with the exception of more or less well marked black cross lines in middle of each segment; a bluish white or silvery pubescence covers the entire abdomen, but is very sparse on the dorsal parts. Legs brownish black; tarsi almost black, and more or less densely covered with white hairs. Wings, subhyaline. Veins bluish white, base ferruginous. Described from many bred and captured specimens.

Male. Length 1.5mm to 2mm. Very different in appearance from female. Eyes confluent, very large, brilliant coppery; a very marked difference in the size of the facets, those on upper surface being very large and metallic copper, those below and surrounding trophi becoming suddenly small, black, with bronze reflections; trophi reddish black, dwarfed; antennae black, with light, yellowish brown pubescence in front. Thorax above in-

tense black, velvety with a bluish luster; underside grayish. Legs reddish with black tarsi. Wing hyaline, veins and base bluish white. Abdomen; above, black with posterior margins of segments edged with gray; undersides of segments 2 and 3 light, reddish gray, the others blackish, with gray posterior margins. Sexual organs black. Thorax and abdomen very sparsely clothed with white pubescence. Described from three bred specimens.

Larva. Length when full grown 5.5mm to 7mm. Normal shape and general appearance differ from S. p e c u a r u m by the much more irregular markings of segments and head. A majority of the larvae possess one or two lateral spots on club-shaped posterior third of body. Head lacks the regular arrangement of spots and lines, which become confused; the two black spots on each side present. Antennae uniformly pale, much longer than in p e c u a r u m, slender and three jointed; first joint almost twice as long as joints 2 and 3 together, and a little bent; at base three times and at tip twice as thick as second joint, which is nearly uniform in width, tapering but very slightly toward the tip; joint 3 small and pointed, about one fifth as long as joint 2. Mentum similar to that of S. p e c u a r u m, but distinguished by a flatter apex, by the possession of three erect bristles on each side, starting from round pores, which decrease in size toward base; a fourth very small bristle close to base, and in line with the bristles above; the sides of mentum have on each side four sharp teeth. Labrum and labium not different from those of p e c u a r u m. Mandibles possess but seven teeth in the first row; the three first nearly uniform in length; teeth 4 to 7 gradually decrease in length; tooth 4 much the longest of all; the two teeth in the second row similar to those of p e c u a r u m. Maxillae and maxillary palpus also similar. Fans similar, but the hairs lining the inside of the scythe-shaped rays are thicker and nearer together. Prolegs, more slender, last joint bearing a crown of hooks, usually bent suddenly toward head. Tip of abdomen similar to that of p e c u a r u m. Breathing organs quite different; the three main trunks branch each six times, and the branches enter the trunk from both sides. Full grown larvae show also the newly formed, coiled breathing tubes of the pupae through their skin. Described from many specimens.

Pupa. Average length 3.5mm; shape and colorations as in S. p e c u a r u m. The thoracic filaments consist only of the six original rays, which do not branch. On dorsal surface of the posterior margins of abdominal joints 4 and 5 is a row of eight anteriorly curved hooks, similar to those of p e c u a r u m, but

none on joint 3; anterior margin of joint 9, and of subjoint with a continuous row of smaller, anteriorly curved hooks; joints 7 and 8 unarmed dorsally; ventrally joints 6, 7 and 8 have each four minor hooks.

Cocoon. Length 3.5mm. Neater than that of any other species known to me, being formed of fine threads, lined with gelatinous ones. The web is quite dense, uniform, with well defined, sometimes thickened rib.s. The cocoon is always securely fastened singly to leaf or stick, and if many are fastened on the same leaf, they do not crowd each other. It fits snugly about the pupa, which is so securely anchored inside as to be with difficulty extricated.

Several female specimens taken by Messrs MacGillivray and Houghton at Axton N. Y. in company with S. v i t t a t u m agree perfectly with Coquillett's description, though not so well with Riley's. Coquillett's description of the female in United States Dep't Agric. bulletin 10, new series, reads as follows:

Abdomen of female gray, marked with a velvet-black fascia on segments 3 and 4, and sometimes with two subdorsal spots of the same color on 2, 5 and 6; thorax bluish gray with three black vittae.

The blue color on the abdomen spoken of by Riley in his description is not distinguishable in the dried cotype specimen, the posterior segments appearing grayish. In the male the thorax is velvety black, with a few pale yellow hairs, specially anteriorly and posteriorly. The abdomen is velvet-black, the posterior margins of segments sometimes pale. The fore tibia possesses a single spur, the middle and hind ones each with a pair [pl.38, fig.12]. All tarsal claws of the male trifid [pl.38, fig.18]; of the female bifid [pl.38, fig.16].

It may be mentioned that what Riley calls mentum I have termed labium. To Riley's description of the larvae may be added that the apical pair of bristles of the mandible is not present or at least is not differentiated from the other hairs; the labrum and hypopharynx [pl. 33, fig.11, 3] resemble those of other species; the labium has four pairs of setae [pl.33, fig.4], one of which is quite small; the maxillary palpus has no setae on the last joint, and but few hairs on the basal joint. No spines are apparent at tip of the last abdominal joint of pupae.

the other spines and hooks are as described by Riley. This species has been reported from New York. I have also seen specimens from Moscow and Albion Id., Lawrence Kan. and Axton N. Y.; those from Idaho and Kansas belonging to Professor Aldrich.

S. mexicanum Bellardi

Saggio etc. Apx. 6. 1862

Male. Black. Head black, front prominent, triangular, with whitish reflection; antennae black, first joint and base of second yellow; face prominent, black, the epistome yellowish, with grayish reflection; palpi black, paler at the base; thorax wide, subquadrate, slightly convex, black, with a grayish reflection, with yellow pile? (aureo-squamuloso); humeri pale; pleurae black, anteriorly and posteriorly with fuscous spots; scutellum fuscous; the halteres white; abdomen black, the base of the second segment pale yellowish, the second, third, fourth and fifth pale yellowish on the sides; fore and middle coxae wholly yellow, hind ones fuscous with yellow tips; fore femora wholly yellow, the middle and hind pairs fuscous black, at base and tip yellow; all tibiae fuscous-black with yellow bases; fore tarsi wholly black; middle tarsi black, with bases of all the joints yellow; hind tarsi black with base of first joint widely and second joint narrowly yellow; wings hyaline iridescent. Length 4mm; extended wings 9mm.

Mexico.

S. minutum Lugger

(= S. vittatum Zett.)

Minn. Agric. Exp. Sta. Bul. 48. 1896. p.202.

The bulletin mentioned above contains a figure of the female of a species which is said to be common near Minneapolis from May 15 to June 1. No description is given excepting the statement that it is very small. The figure represents a fly with an unstriped thorax, the abdomen with a dark fascia on each segment, the fascia covering nearly the entire dorsal surface of each segment, excepting the narrow basal and lateral margins. Its legs are bicolored. Specimens bearing the label S. minutum received for study from Mr Washburn proved to be S. vittatum Zett.

S. occidentale Townsend

Psyche. 1891

Female. Cinereous; abdomen light fulvous. Head cinereous, eyes black; face cinereous, raised and somewhat darker in the center, sparsely clothed with fine silvery hairs; front cinereous,

widened below into a crossbar, a prong invading the orbital area on each side; silvery pubescent on occipital margin; proboscis black, brownish at the tip, palpi black; antennae cinereous, with short silvery pubescence, the two basal joints longer than the following joints, which are nearly equal in length; occiput cinereous with silvery pubescence around the margin.

Thorax cinereous, mesoscutum entirely covered with silvery pubescence, with two dorsal lines and usually a fainter median line between them; pleurae fulvous posteriorly, scutellum black, silvery pubescent. Abdomen light fulvous sparsely covered with short silver pubescence. Second, third and fourth segments above with a brown cross band shading to darker on the sides and in the middle, particularly on the third and fourth segments, remaining segments with a broad, median, dorsal, cinereous band, bounded laterally on fifth, sixth and seventh segments by a curved more or less faint line of brown; venter light fulvous, silvery pubescent. Legs black, silvery pubescent. Wings hyaline, iridescent by reflected lights; halteres white. Length of body 2mm; of the wings 2mm.

Described from many fresh specimens. This species is smaller than either S. pecuarum, or S. meridionale. S. metallicum Bell. from Mexico is given as 2mm long, but the male is described. The female would be much larger.

I have examined specimens from New Mexico, kindly sent me by Professor Aldrich of Idaho, to whom the specimens were sent by Mr Townsend, and named occidentale. The only difference I have been able to discover between this and meridionale is its smaller average size. The tarsal claws are as in meridionale. The abdominal markings were too indistinct, owing to shrinkage, to allow of comparison. For the present I regard it as a small variety of meridionale.

S. ochraceum Walker

Ent. Soc. Lond. Trans. 5:332

Female. Testaceous, with white tomentum; head white; antennae testaceous; thorax ochraceous, with two white stripes; abdomen blackish, testaceous at the base; femora and tibiae with black tips; tarsi black, testaceous toward the base; wings vitreous; veins pale testaceous. Length of body 2mm; of wings 4½mm. Mexico.

This species can hardly be the female of S. metallicum Bellardi.

S. pecuarum Riley

U. S. Dep't Agric. Rep't for 1886. 1887. p.512 (Coquillett considers this a synonym of S. i n v e n u s t u m Walker)

Plate 33, fig.6–11

Female. Length 2.5mm to 4mm. Head uniform grayish slate, clothed with short yellowish hair, which becomes longer behind the eyes; eyes black, with coppery or brassy reflections; antennae black, with whitish pubescence, and with a few bristles on two basal joints, which are tinged with red, joints 1 to 11 gradually diminishing in thickness toward the last, joint 1 the shortest, joints 2 and 3 twice as long as joint 1, joints 4, 5 and 6 as long as joint 1, joints 7, 8, 9 and 10 gradually increasing in length, last joint fusiform, twice as long as joint 10. Maxillary palpi a little longer than the antennae, blackish, with long grayish bristles.

Thorax grayish slate, more or less densely covered with short, yellow hairs, and with usually very distinct markings, consisting of two median dorsal, and two subdorsal broad, longitudinal, sooty black bands, of which the latter curve to posterior edge of patagium, which is reddish at tip; lateral edges of prothorax with fine black sutures; underside of the thorax uniform grayish slate, with sparse yellow hairs, space around the one large stigma lighter; halteres opaque, reddish white; legs uniform reddish brown, densely covered with yellowish hairs; tips of the tarsi blackish; wings subhyaline; larger veins and base reddish brown.

Abdomen nine jointed; joints subequal in length except the last two, which decrease in length; a longitudinal, broad, bluish gray dorsal band extends from near the base of second segment, where it is broadest, to the tip curving downward to the anterior lateral edge of seventh segment; below this band laterally the color is blackish brown, with the exception of a broad bluish gray transverse band on the posterior edge of each of the segments from 1 to 6; underside of abdomen uniform brownish gray, without markings; abdomen densely covered with yellowish hair, which is very long upon the posterior edge of segment 1, forming an overlapping fringe.

Male. Length 1.5 to 2.2mm; differs considerably from the female. Head not visible from above, being occupied by the very large confluent eyes; the remaining parts below the eyes are black, with black hairs and bristles; eyes composed of two different kinds of facets, those above very large, twice as large as those of female, and those in front and surrounding the dwarfed trophi very minute, the dividing line between the sizes being abrupt; antenna similar to the female, more pro-

nounced in color, both the black and reddish being more vivid; maxillary palpi black, and shorter than the antennae. Thorax black above with sparse yellow hairs; legs somewhat lighter in color, tip of the tarsi not black; hairs upon the legs longer than those of the female. Wings hyaline, veins and base yellowish brown. Abdomen black with grayish white posterior margins to the segments dorsally and laterally, and covered with longer yellowish hair. Described from two bred specimens.

Larva. Average length when full grown 7mm to 8mm, subcylindric, the club shaped posterior third of body being twice as stout as the thoracic joints, and joint 4 the most constricted. Translucent when living, dirty white in alcohol. Immaculate in a very few specimens; distinctly marked in the great majority with brownish dorsal cross bands in middle of joints, leaving free a white mediodorsal longitudinal line. Thoracic joints with three irregular rings of the same color; underside more or less irregularly spotted with brown. Head subquadrate, horny, yellowish brown, with a number of brown spots and lines in regular order, and two roundish, approximate ocellate, black dots on each side under the skin, and seemingly rudimentary organs of sight, from which the future eyes originate. Antennae uniformly pale, three jointed, about one third as long as greatest width of the head; joint 1 very stout, fully four times as thick as 2, which is a little longer than 1, straight, slightly tapering toward the tip. Joint 3 extremely small, a mere triangular tip; mentum subtriangular, with apex cut away, and replaced by three groups of very small teeth, of which the central group consists of three teeth, the middle one largest; and the groups on sides, of four teeth, of which the second from center is largest. Sides of mentum, near the apex, with two small teeth each; all the teeth are chitinous and black; a long erect bristle, pointing upward and inward, near each side of mentum; labrum horny, densely covered with hair; mandibles resembling in shape the profile of the inverted last joint of the human thumb, with a series of teeth in place of the nail. Teeth difficult to see, owing to the presence of five distinct brushes of hair; on extreme lower tip of mandibles three large teeth; below them a series of 11 slender and very pointed teeth, of which the first two are the smallest, teeth 3 to 9 increasing and teeth 10 and 11 decreasing gradually in length; a second series of teeth below them consists of two triangular teeth, of which the first is largest. Maxilla stout, fleshy, with an internal thumb-shaped lobe; maxillary palpus two jointed, first joint cylindric; second very short, crowned with a regular circular row of short spines or warts; labium

horny with two brushes of hair above, between which is a very small ligula, covered with a small brush of hairs. Fans, composed of stout stem, bearing about 46 scythe-shaped rays, lined on the inside by very minute, equidistant, erect hairs of equal length. Thoracic proleg, faintly four jointed, subconical, retractile (introversible), very thin and transparent, crowned with about 20 rows of short, sharp hooks, apparently arranged in a circular manner; the hooks, of which 10 are in each row, seem to be movable to a certain extent, and are fastened or hinged to small chitinous rods in the epidermis. Tip of abdomen formed by a subcylindric body crowned with rows of hooks. Breathing organs below these hooks and on the upper side of abdomen; they consist of three short, cylindric, soft and retractile tentacles, which connect with large internal tracheae. In full grown larvae a spot more or less dark is seen on each side of thoracic joint; it is produced by the formation of the coiled breathing tubes of the future pupa.

Pupa. General color when fresh, honey-yellow; prothoracic filaments brown, and the abdomen dorsally also tinged with brown, except a mediodorsal space. All the members have also a fine brown marginal line; prothoracic filaments consisting of six main rays, issuing from the basal prominence and subdivided two or three times, so that in most cases as many as 48 terminal filaments can be counted. Abdominal joints three, four, and five, each with eight well separated, dark brown and anteriorly recurved hooks. The four on each side separated by a mediodorsal space; those on joint 3 less conspicuous than those on joints 4 and 5; joint 6 without armature; joints 7, 8 and 9, and also subjoint less distinctly armed near anterior margin with a continuous dorsal row of very minute posteriorly recurved points; ventrally joints 6, 7, and 8 have each four very minute anteriorly recurved hooks.

Cocoon. Average length 3.5mm. Not completely made and not entirely covering the pupa, but tightly surrounding its larger portion. Shape very irregular, with no distinct rim at the upper edge, which is more or less ragged. The threads composing it are very coarse, and the meshes rather open and ordinarily filled with mud. Not always fastened separately to objects, but frequently crowded together without forming, however, such corallike aggregations as in some of the northern species.

That part which Riley called the labium in the above description, appears to be a combination of labium proper and the hypopharynx. Often in dissection these two parts stick together and appear as one, but with a little care the hypo-

pharynx can always be removed entire. To the above description I may add that the apical pair of bristles of the mandibles [fig. 6] are present, though slender, the labrum and hypopharynx [fig. 7] as in other species; the labium [fig. 8] has the middle tooth trifid, and there are three setae (instead of one, as Riley has it) in each row on the ventral side. The maxillary palpi have a few slender setae and there are also a few on the basal joint [fig. 9].

I find eight abdominal segments plus the anal segment in the pupa [fig. 10], and not nine, as Riley has it. Therefore the eight hooks are on each of segments 2, 3 and 4, and not 3, 4 and 5. Dorsally, on each of segments 5, 6 and 9 is a transverse row of minute caudad projecting spines; 7 and 8 with slightly larger ones. Ventrally, segments 5, 6 and 7 each with four large spines curved cephalad. In the Cornell University collection are four specimens of adults, two males and two females, obtained from Riley.

S. pictipes Hagen

Bost. Soc. Nat. Hist. Proc. 1880. 20:305

1895 S. innoxium Comstock, Manual for the Study of Insects

Male. Eyes very broadly contiguous, the large facets distinctly separated from the small by a horizontal line. Face small, as broad opposite the insertion of the antennae as its length, considerably narrowed below; a deep groove on either side running obliquely to the inferior angle, the median part arched; in color grayish pruinose, or in some reflections almost silvery; antennae situated at about the lower fourth in profile; in color black with a slight pruinosity; palpi black, slender, the first three joints somewhat thickened. Metanotum thinly covered with golden pubescence; in color velvet-black, the lateral margins and a spot running upward and inward from each humerus gray and yellowish gray, but somewhat variable in different reflections. Mesad of these gray humeral spots is a pair of small silvery spots. Pleurae, pectus and coxae, gray pruinose, showing in some reflections the black ground color. Abdomen with eight visible segments, in color deep velvet-black; under the leaflike margins of the first segments and the sides of the remaining segments gray, or in some reflections silvery pruinose. Legs black or dark brown, the basal part of the dilated hind metatarsal joint yellow, in some specimens the ex-

treme base of the tibiae yellowish, with a single short spur on the fore tibiae, and a pair of longer ones on middle and hind tibiae [pl.38, fig.8]. Fore and middle tarsi slender, hind ones widened, all claws trifid [pl.38, fig.8, 17]. Wings hyaline or slightly tinged; the anterior veins thickened, the remainder slender [pl.36, fig.7]. Knob of halteres orange yellow. The male genital organs are short though rather complex, consisting of a pair of outer sheaths, then a pair of elongate blunt processes, within which are two pairs of hooks; the outer, shorter pair are incurved and clawlike; the longer, inner pair are slender, with some outwardly projecting hooks. Length 3.5 to 4mm.

Female. Eyes with a small deep sinus on each side, just about the base of the antennae, above which the front is a little longer than wide, and a little wider above than below. Face a little wider than the narrow part of the front, the sides parallel, its surface gently and evenly convex, clothed with white hairs; antennae tapering more than in the males, the first two joints yellowish. Basal joints of palpi stouter. Facets of eyes uniformly small, the eyes much smaller and the posterior orbits conspicuous. Thorax like the head, opaque gray pruinose. Metanotum with three slender, deep brown or black stripes, the lateral ones gently incurved back of the anterior knoblike dilation. Abdomen velvet-black, the second segment (or the part beneath the leaflike margins of the first) and the posterior margins of three following segments except at the center, opaque gray or grayish white; the remaining segments, and leaflike sides of the first, lightly pruinose; venter gray; in some specimens with a small black or grayish triangular spot on center of the dorsum of segments 3, 4 and 5. The legs grayish, in some specimens quite pale; the tips of some or all the tibiae usually, and the tarsi nearly always, black, except the bases of hind metatarsi and sometimes the middle also, which are yellow. The tibial spurs and hind metatarsi as with the male. Tarsal claws simple [pl.38, fig.20]. Wings as with the male. Knob of halteres yellowish white. Length 3 to 4mm.

I have compared this species with Hagen's type, (larvae, pupae and adults) and find that they agree perfectly. The apparent discrepancy in comparing Hagen's description[1] with the one given above is due to the fact that Hagen described his from bottled material. His description agrees very well with alcoholic material of this very common Ithaca species. Hagen was in error in regard to the number of respiratory filaments of

[1]Bost. Soc. Nat. Hist. Proc. 20:305.

the pupa, in stating that there were but eight; for, on examination of the Cambridge material, nine filaments were counted. Coquillett (1898) says of the male mesonotum, "usually with three black vittae"; but this I have found to be an exception rather than a rule.

Recorded from New York, Texas, California, and Moscow Id. (Collected by Aldrich).

Larva. Length 10 to 12mm. Plate 36.

The fans of this species have about 60 rays; the cilia and the regularly arranged setae on the inside of the rays are very distinct. The antennae, light brown in color, are three jointed, the second joint about one third as long as the first, the third very short and pointed, the extremities of the first and second are hyaline, the two small budlike processes at the end of the first and the second joint are brown. The mandibles possess the apical pair of bristles, the apical teeth are quite black, the others paler; the maxillary palpus with a few scattered bristles on the shaft and at the base. Labrum and hypopharynx as usual, in the latter the lateral hornlike processes are quite prominent. Labium with the toothed area rather narrow, the lateral and middle teeth elongate, the ventral surface with two rows of 10 or 11 bristles each [fig.3]. The thorax and abdomen are a deep black; paler at the incisures, and on the ventral surface, particularly toward the caudal end. A narrow black longitudinal, ventral stripe is often present. The blood gills consist of three many branched papillae.

Pupa. The two thoracic respiratory organs each consist of nine filaments; eight of which are about equal in length, the ninth arises a little lower on the shaft, and is somewhat shorter [fig.8]. On the dorsal surface of each of the segments 2, 3, 4, and 8, are eight black hooks curved cephalad, those on the second and the eighth segments being much smaller than the others. Ventrally 5, 6 and 7 each, with four double, curved hooks, on the caudal segments are two very short blunt spines, and three smaller ones on each side of 3, 4 and 5. The pupal case is of the boot-shaped type [pl.35, fig.5].

S. pulchrum Philippi

Chilian Diptera. 1865. p.633

1896 S. tarsale Williston, Dipt. of St Vincent, p.268

Female. Abdomen black, the proximal segments opaque, the distal four segments shining. Length 2mm.

Front and face black, with a light gray reflection. Antennae yellow; the distal joints somewhat brownish. Mesonotum deep

black; in front, opaque with a silvery shimmer, and with sparse, short, curly, golden yellow tomentum; behind, shining. Pleura black, whitish pruinose. Abdomen black, the basal segments opaque, the distal four segments somewhat shining, and with a delicate whitish pruinosity. Legs reddish yellow; tarsi black, except that the proximal half of the middle and hind metatarsi is light yellow; first and third joints of the front pair each with two long hairs; second and third joints of the same pair dilated, the fourth and fifth very small; hind metatarsi elongate and stout, the following two joints a little dilated, the fourth and fifth small. Wings hyaline; veins yellow. *Williston*

Three specimens. The above synonymy is according to Hunter.

This species seems to resemble greatly S. venustum excepting for the color of its legs.

S. quadrivittatum Loew

Berl. Ent. Zeitschr. 1862. Centur. 2, p.186

Black opaque, the thorax with four white vittae; the halteres yellow; middle and hind tibiae and tarsi white banded; wings hyaline. Body 1.67mm; wing 1.67mm.

Black, opaque. Antennae fuscous; dorsum of the thorax with four longitudinal lines, the posterior margin whitish pollinose; scutellum spotless; the pleural spots and the metanotum whitish pollinose; the legs fuscous black; the knees and the bases of the metatarsi of the fore legs, the basal rings of the middle and hind tibiae, the metatarsi excepting the tip, and the bases of the second and third tarsal joints are white; halteres yellow; wings hyaline, the heavier veins deep yellow. Cuba.

S. reptans Linnaeus

Fauna Suec. 1803. 1761 (Synonymy according to Schiner, 2)

1767 sericea Linnaeus, Syst. Nat. 12:978, no. 58
1776 erythrocephala DeGeer, Ins. 6:161, no. 37 (Tipula)
1781 reptans L. Schrank, Enum. Ins. Austr. p.985 (Culex)
1804 argyropeza Meigen, Syst. Beschr. 1:291-92
1818 reptans Meigen, Syst. Beschr. 1:291-92
1818 sericea Meigen, Syst. Beschr. 1:296-98
1818 elegans Meigen, Syst. Beschr. 1:296-99
1818 variegata Meigen, Syst. Beschr. 1:292-93
1823 reptans Fries, Obs. Entomol. Pars 1 Monogr. Simul. 1:13
1830 cincta Meigen, Syst. Beschr. 6:311-14
1838 posticata Meigen, Syst. Beschr. 7:52, 21

Male. Velvet-black; dorsum of the thorax with a silvery white margin, spotlike on the humerus, broadly interrupted in front;

visible only in certain lights. Pleura also with a whitish reflection; abdomen with silvery white spots on the second and on the last two segments, wanting in rubbed specimens; the posterior margin of the first segment with long and dense brownish cilia. Head black, face grayish white; antennae and palpi brownish black, the former more slender than is usual with the members of this genus, with whitish reflections on some parts. Legs dark brown; front coxae yellowish, fore tibiae silvery white outwardly; middle tibiae yellow at the base, hind tibiae likewise, though in less degree, light brown, with a whitish reflection; metatarsi of the hind legs yellowish at the base; the hairs of the fore and hind femora, and particularly on the extensor surface of the hind tibiae, conspicuous. Halteres bright yellow; wings purely hyaline, with delicate and transparent veins, those of the anterior margin being somewhat thicker and more conspicuous; the wing surface with a golden brown reflection; the media not petiolate. The short, scattered hair of the thorax seldom distinct, the color of the legs variable in intensity.

Female. In coloring does not resemble the male in the least. The ground color is blackish brown; the dorsum of the thorax covered with a depressed yellow pile, on the margins with a whitish reflection, on the center with a grayish reflection. The pleurae grayish white. Abdomen somewhat shining; on the sides whitish or yellowish gray; on the venter, at least at the base, in living specimens, yellow, which is continued around on the dorsum in some specimens, usually not distinct in dried specimens. Legs brown, usually paler than those of the male; the tibiae, with the exception of the tip, and the fore coxae whitish or yellowish white, the tips of the tibiae and the tarsi black, the basal half of the hind metatarsi and sometimes also the extreme base of the following joint yellowish. Front and face gray; antennae and palpi brown, the former paler at the base. In other particulars as with the male. Length 2 to 3mm. Translation from Schiner, *Fauna Austriaca*, 2:365

According to Schiner [*loc. cit.*] this is the species whose life history has been described by Fries, Westwood and Heeger. According to Schiner also, s e r i c e a is a synonym of r e p t a n s. Of s e r i c e a Westwood writes that the larva possesses three unbranched blood gills, and that the pupa has eight thoracic respiratory filaments on each side.

This European species has been reported by Lundbeck as occurring in Greenland. (Diptera groenlandica, 1898)

S. tamaulipense Townsend

N. Y. Ent. Soc. Jour. 1897. 5:171-72

Female. Length 1.5mm. Near S. meridionale, but smaller, and the outer one on each side of the three thoracic lines not curved outward at posterior end. Eyes velvet-black, face and front silvery; front with usually a trace of a linear black vitta, in one specimen very distinct, in another entirely wanting. Antennae yellowish with a silvery covering. Thorax silvery, with three longitudinal lines; middle one longest, very narrow and linear; outer ones heavier, straight, slightly divergent posteriorly. Looked at directly from above, the outer lines appear curved, outwardly convex. Scutellum and metascutum below scutellum, both brownish in some lights but in others they appear wholly silvery, the various portions appearing different in color to the view at the same time. Abdomen silvery but the third and fourth segments wholly brownish, sometimes with a round median spot on each. Legs yellowish, shaded with silvery, tarsi blackish or brownish; hind metatarsi yellowish except at distal end. Wings clear, whitish, veins dilute yellowish. Halteres and wing bases pale dilute yellowish.

Four females, Reynosa, Tamaulipas. A small species taken on the windowpane of railroad car, May 1. Described from four dried specimens. *Townsend*

S. venustum Say

Acad. Nat. Sci. Phila. Jour. 1822. 1:28 and Compl. Wr. 2:51

1862 molestum Harris, Ins. Inj. to Veg.
1870 piscicidium Riley. Am. Ent. 2:367

(Synonymy according to Coquillett, 1898)

Male. Velvet-black. The eyes are very large, separated by a single line, reddish yellow, lower half black. Thorax velvet-black, a bright pearlaceous, dilated line each side before, and a large pearlaceous spot behind, sides beneath varied with pearlaceous. Abdomen with an oblique pearlaceous line at base, and two approximated lateral pearlaceous ones near the tip. Tibiae above, and first joint of four posterior tarsi white. Wings with yellow and iridescent reflections. Poisers black, capitulum bright yellow, dilated. Near Louisville Ky. at Falls of the Ohio. *Say, loc. cit.*

Superhumeral gray stripes metallic, no metallic spots between them; mesonotum not vittate with black. *Coquillett*[1]

The following description of the males is based on specimens from Ithaca N. Y. and Battle Creek Mich. Velvet-black. An-

[1]U. S. Dep't Agric. Bul. 10, n. s. 1898.

tennae black, covered with short whitish pile; palpi black, thorax velvety black, with an oblique bluish white metallic humeral spot, the posterior margin also metallic; scutellum velvety black; and pectus black, grayish pruinose. Abdomen deep velvety black; on each side on the margin of the first abdominal segment is a tuft of fuscous hairs, underneath which the segments appear metallic. The posterior part of the venter appears metallic. Legs, black and yellow. The extensor surface of front tibiae, and a basal ring on the middle and hind tibiae, silvery white; the fore coxae, basal half of all femora, tibiae and metatarsi, and sometimes also bases of some tarsal joints more or less yellowish; the rest black. The anterior tibia with a rudimentary spur, middle and hind pair each with two spurs; tarsal claws trifid. Halteres orange-yellow; wings whitish hyaline. Length 2 to 2.5mm.

Female. Black. Antennae black covered with short whitish pile; two basal joints usually yellowish; palpi black with pale hairs; face and front gray pollinose. Dorsum of thorax black, bluish gray pollinose, particularly on the sides and front corners, sparsely covered with very short yellow hairs. Scutellum black, with erect black bristles; pleura black, gray pollinose. Abdomen black, the anterior segments velvety, the posterior ones subshining brown. Legs yellowish, middle and hind coxae brown, tips of femora and tibiae, the whole of fore tarsi, tips of the middle and hind, first and second tarsal joints and usually the whole of the remaining joints, black. Sometimes the femora are wholly black. The extensor surface of all tibiae is silvery white. The first and third joints of the fore tarsi are each provided with a pair of long black hairs near the tip, besides the usual shorter ones. The anterior tibia with rudimentary spur, middle and hind ones each with a pair. Tarsal claws simple. Wings whitish hyaline, the heavy veins yellowish brown, quite yellowish at the base at point of attachment. Halteres pale yellow. Length 2 to 3mm.

This species is very common in the Adirondacks, where it proves to be a great annoyance to travelers. It seems to have a wide distribution, having been reported by Mr Coquillett[1] as occurring in Canada, New Hampshire, New York, Michigan, Minnesota, Wyoming, British Columbia, California, Texas, Louisiana, Mississippi and Florida. I have found it in Ithaca N. Y., and I have seen specimens from Moscow, Marsh and Albion Id., and Battle Creek Mich.

[1] U. S. Dep't Agric. Bul. 10, n. s. 2. 1898.

Larva. Specimens from Wilmuth and Axton N. Y. [Pl.37, fig.1 to 6]. Pale brown with paler incisures; head brown, labrum hairy, with serrated edge; fans with 50 to 60 rays; mandibles with a pair of apical setae; hypopharynx as usual; labrum [fig.6] with middle tooth rather prominent, its ventral surface with five setae in each of the two rows; each of the three branches of anal papillae with a number of lobes.

Pupa. Six branched respiratory filaments; eight hooks curved cephalad on dorsum of each of abdominal segments 3 and 4; four hooks curved cephalad on ventral surface of each of segments 5, 6 and 7; a close transverse row of small caudad projecting spines on dorsum of eighth segment, and a pair of short, blunt tubercles on the anal segment. Cocoon of the wall pocket type.

S. venustum, var. a

Plate 37, fig.8–14

A number of specimens bred from larvae and pupae taken from Fall creek, Ithaca N. Y., differ in the adult stage from venustum as described above in being uniformly smaller (length 1.5mm); having the base of wing brownish and not yellow, and in having the last four abdominal segments of the female a shining black instead of brown. The larva differs as follows: in size averaging less than two thirds that of venustum, labrum with its toothed edge wider in proportion to its size than in venustum, its teeth more nearly of a size, the ventral setae three in each row plus a very small one. The pupa differs in having 10 respiratory filaments in each tuft, the hooks on segment 2 more distinct, and the tubercles on the anal segments apparently wanting.

S. piscicidium (Synonym of venustum) Riley

Am. Ent. 2:367

According to Coquillett this is a synonym of S. venustum; but I have larvae and pupae from Professor Needham, taken at Saranac Inn N. Y., which, though agreeing with Riley's figures of piscicidium, differ decidedly from the larvae and pupae of S. venustum taken by Messrs MacGillivray and Houghton at Axton N. Y. in 1901, and by Professor Comstock at Wilmuth N. Y. Of the adults of the Saranac Inn material I have only alcoholic specimens, hence can not state definitely wherein these differ from S. venustum from Axton N. Y. excepting that it averages a little larger in size. For the present I shall regard it as a variety, though in all the material

of larvae and pupae studied I did not find transitional characters. Should a difference be discovered on the examination of more fresh specimens of both varieties of adults, the specific name of p i s c i c i d i u m must be revived. Riley's description is as follows:

Female. Head velvet-black; eyes brownish; antennae with joints 1, 2, 3 and 11, subequal in length, each of the others half as long. 1 and 2 rufous, 3 to 11 inclusive black and gradually diminishing in thickness to the last, which is fusiform; palpi longer than the antennae, black. Thorax velvety black with faint fulvous pubescence above; halteres opaque and white. Abdomen nine jointed, joints equal in length except the last two, which are smaller and smaller; dorsally velvety black, laterally and ventrally, especially towards the base and at the incisures, inclining more or less to rufous. Legs with the front trochanters white or fulvous, and the middle and hind ones more dusky; the coxae all either rufous or fulvous; the femora all dark, though sometimes (two specimens) the base is paler. Front tibiae with the upper three fourths white, the rest black; hind tibiae with the upper two thirds white, the rest black; middle tibiae with about the upper one half white, the rest black; front tarsi black; middle and hind tarsi with the upper half of first joint white or rufous, the rest black. Wings subhyaline, with the veins fuliginous. Length of the body (in alcoholic specimens) .14 to .17 inch. Mumford N. Y.—Riley

Larva [pl.37, fig.2,5,7]. Pale grayish, slightly darker dorsally. Head of the usual shape, brown with darker margins. Fans with 50 to 60 rays, the longer cilia quite prominent. The apical pair of bristles of the mandibles present; the labrum with a serrated margin; the maxillary palpus with a few setae on last joint and also on base; hypopharynx as usual; labium with the toothed margin comparatively narrow; its teeth nearly uniform in size, with seven setae in each row on the ventral surface [fig.5]. Anal papillae, three much branched lobes.

Pupa. The pupa with eight branched respiratory filaments, with four hooks curved cephalad on ventral surface of each of the segments 4, 5, 6 and 7, those on the fourth being quite small. On the dorsal surface of each of segments 3, 4, 5 and 6 are eight hooks curved cephalad, those of 5 and 6 being very small; and on the dorsal surface of 7 and 8 are a number of hooks curved caudad. The anal segment with two short, blunt spines. The pupal case is of the " wall pocket " type.

In order to obtain characters to separate the adults of the Fall creek, Saranac Inn and Axton varieties of v e n u s t u m,

a number of them which were nearly ready to emerge were drawn from the pupal skins and examined for distinctive structural characters; but, excepting the difference in size, none were observed. With freshly bred material, perhaps specific characters might be obtained.

The larvae of piscicidium is briefly described by Riley in the paper just quoted.

S. virgatum Coquillett

U. S. Nat. Mus. Proc. 1902. 25:97

Male. Head and body black, antennae and mouth parts dark brown, thorax gray pruinose, mesonotum marked with a narrow median and laterally with a very broad velvet-black vitta (viewed directly from above), mesonotum sparsely covered with short, appressed hairs; abdomen on first six segments opaque, velvet-black, a large silvery white spot on each side of the second and sixth segments, venter near each side with an interrupted yellow vitta on segments three to seven, composed of appressed hairs, on each side of base of abdomen is a large cluster of yellow hairs, and a smaller cluster on each side of segments three to five; femora and front tibiae yellow, their apices brown, middle tibiae brown, a yellow ring beyond the base, hind tibiae brown, the extreme base yellowish; tarsi black, broad base of first joint and extreme base of the second on the middle and hind tarsi light yellowish; wings hyaline, veins along the costa yellowish brown, the others nearly hyaline; halteres yellow.

Female. Differs from the male as follows. Vittae of mesonotum brownish, the median vitta dilated posteriorly, wider than either of the lateral ones; viewed from in front the mesonotum appears whitish pruinose and with two velvet-black vittae; abdomen on the first five segments and sides of the sixth opaque, gray pruinose, and with a velvet-black fascia at bases of three to six, broadly interrupted on six, the middle of which and the portion of the abdomen beyond it is very thinly pruinose and of a dark brown color. Length nearly 3mm. In August; Las Vegas Hot Springs, N. M.

S. vittatum Zetterstedt

Ins. Lapponica. 1844. p.803

(= S. tribulatum Lugger)

(According to Coquillett, decorum Walk. 1848 and argus Will. 1893 are synonyms)

Female. Gray; nearly bare; dorsum of thorax with five black stripes, the median one entire, the intermediate pairs inter-

rupted, the exterior pair spotlike. Each segment of the abdomen with a black dorsal stripe and basally on each side with a black spot, the penultimate segment black. Wings whitish hyaline; halteres white; legs fuscous black, the front side of anterior tibiae, the base of the middle and hind tibiae, and the base of the middle and hind metatarsi white. Length 3mm. *Zetterstedt*

Female. The abdomen gray, bases of segments 3 to 7 or 8 marked with a velvet-black fascia produced backward in the middle and at the ends. Length 2 to 4mm. New York, Minnesota, Nebraska, Kansas, California.

Male. Hind tarsi bicolorous, mesonotum gray on sides and hind margin, center largely velvet-black; without gray streak extending inward from humerus; sides of abdominal segments 4 to 7 with silvery white hairs. *Coquillett*[1]

The markings of the female of this species seem somewhat variable. The thoracic markings are usually quite distinct. The median stripe is nearly of uniform width excepting at the posterior end, where it becomes narrower; the intermediate stripes are *f* shaped, the extremities larger, the intermediate portion usually a hair line, sometimes obsolete; the exterior pair usually elongated spots. The abdominal markings are as described by Coquillett, though occasionally there are additional disconnected, velvet black lateral spots, one on each side on segments 3, 4 and 7, and a pair on 5 and 6. Sometimes also, owing either to the contracted condition of the abdomen or to the fasciae being narrow, only the black projections of the fasciae are visible on the more posterior segments, giving the appearance of three spots on each. The legs are often gray; the femora and tibiae paler at the base, the tibiae black at tip, the tarsi deep black except basal portion of middle and hind metatarsi. Fore tibiae with one spur, middle and hind with a pair. Tarsal claws of female simple.

Some specimens from Brookings S. D., received from Professor Aldrich, and which are the males of v i t t a t u m, possess the following characters:

Male. Velvety black, antennae and palpi dark brown; dorsum of thorax velvety black with the anterior and lateral margins

[1]Bul. 10, n. s. 1898. p.63.

narrowly, and posterior margins in front of scutellum, widely silvery gray; also two narrow longitudinal gray stripes on dorsum. Or the dorsum might have been described as silvery gray with three very wide velvety black longitudinal stripes, abbreviated behind. Pleura black, bare; scutellum velvety black; metanotum silvery gray; abdomen velvet-black, the sides of first two or three segments of the ventral surface with a silvery reflection in some lights; legs black, the tips of the fore femora, the basal half of fore and hind tibiae (sometimes the middle one also) the basal two thirds of hind metatarsi, and the extreme base of the second hind tarsal joint, yellow. Fore tibiae with a single spur, middle and hind tibiae with each two; tarsal claws tridentate. Halteres bright orange-yellow. Wings hyaline, the vein yellow. Length, 3mm.

In an article by Lugger[1], it is stated that in S. t r i b u l a t u m the male is much smaller than the female, having very large brilliant, red eyes that meet on top of the head; the body is velvety black with bright golden yellow and blue spots; the female is gray with black markings. This species is said to be most abundant in Minnesota, where it is called "the black fly." No further description is given; the figures of the male and female agree with the description of S. v i t t a t u m . Some specimens sent by Mr Washburn of the Minnesota Experiment Station, labeled S. t r i b u l a t u m proved to be S. v i t t a t u m . I have specimens of larvae and pupae which belong to S. v i t t a t u m , which were sent to me by Professor Needham, he having obtained them from Mr J. C. Bradley of Philadelphia.

Larva (of S. v i t t a t u m). Somewhat mottled gray, the sides of each segment blackish. The larvae and pupae were collected by Mr J. C. Bradley, Philadelphia, 1901. The head is of the usual reddish brown color; the pale yellow antennae long and cylindric, the second joint about one third the length of the first, the third is a pointed process at the tip of the second. The fans have about 40 rays, the cilia being relatively minute. The mandibles are provided with three large apical teeth besides the row of secondary ones; the apical pair of bristles is present. The maxillary palpus has a few spines, and a tuft of a few spines on the basal joint. Hypopharynx and labrum apparently like those of other species. The labium has an elongate middle tooth, those at the end nearly as long, the

[1]Minn. Agric. Exp. Sta. Bul. 48, p.207.

intermediate ones short [pl.35, fig.2], and there are six bristles in each of the two longitudinal rows on the ventral surface. The three blood gills at caudal end are unbranched.

Pupa. The thoracic respiratory filaments each consist of a single main trunk, from which arise eight branches, each of which divides into two, thus making 16 twigs in all [pl.35, fig.1]. Near the basal margin of the last few abdominal segments, are a few caudad projecting dorsal hooks, and on the tip of the last segment is a pair of blunt spines. The pupal case is of the wall pocket type, from which the respiratory filaments of the pupa project. Judging from the number of respiratory filaments of the pupa, the species described by Osten Sacken in *American Entomologist*, volume 2, seems to belong here.

Simulium sp. C. H. Townsend

Am. Ent. Soc. Trans. April 1893. 15:45

The larva and pupa of a species which appears to differ from S. var. **piscicidium**, are described by Townsend [*loc. cit.*], the only species with which it might be confused. Specific characteristics are as follows:

On the dorsal surface of the head are several rows and groups of nearly concolorous markings . . . Antennae pale, nearly as long as one half anterior width of head, three jointed, first joint very elongate, and narrow, not swollen, slightly curved, with a somewhat faint transverse suture on basal two fifths, cylindric below suture, beyond the suture very slightly and somewhat irregularly narrowing to tip; second joint narrower than tip of the first, straight and of equal width except slightly widened at base, a little more than one third as long as first joint, and with two small, triangular budlike processes, one on each side at the base, springing from the junction of the two joints and approximated to the second joint: third joint extremely small, short, minute, triangular, but little longer than wide, about the same shape as the minute processes at base of second joint. Fans consisting of about 60 scythe-shaped rays each, microscopically thinly hairy . . . Mandibles furnished with teeth on inner side at apex; four large teeth on apex, nine or 10 teeth behind these, gradually decreasing in size, except that the second of these is larger than the first, a large tooth still behind these; with a small one directly beside it . . . Thoracic proleg with at least 30 obliquely longitudinal rows of hooks, and probably more; at base of these there is a marginal transverse row of bristles on side toward body (the leg being flexed forward) extending around laterally, but wanting on outer surface . . . Blood gills a soft, retractile, primarily three branched organ just anterior

to these on dorsum, each branch being subdivided into five smaller branches or papillae. Length 11–13mm. Width of head about 1mm. Of anal portion $1\frac{3}{5}$mm. [The figure given by Townsend shows the mandible with the apical bristles.]

Pupa. General color pale brownish yellow on the thoracic portion, abdomen darker; head, wing and leg cases, and filaments pale yellowish, the head sometimes brownish; prothoracic filaments arising from a single stalk on each side, which branches at base into usually eight filaments; these do not subdivide. Third and fourth abdominal segments with five or six brown hooks or spines on posterior margin of dorsum. Length excluding filament, 4.5mm.

Cocoon or case. Massed in coral-like aggregation. Open at top but enveloping all of the pupa, except the filaments or the extreme anterior portion of the hunchbacked thorax. Length 4mm. Abundant in a small stream in one of the branches of Grand cañon. July 8–11, 1893. This branch or side cañon, is one down which the Hance trail leads, being situated about 30 miles in a straight line n. n. w. of Flagstaff Ariz.

Some larvae which I received from Professor Needham, to whom they were sent by Professor Cockerell from Las Vegas N. M., may belong here. The general color however is reddish and it is only about 7 or 8mm in length. The labium has a more irregular outline than most of the other species [pl.35, fig.10]. The mandibles have a pair of apical bristles; labrum, hypopharynx, and mandibles resemble those of other species; on the head are six blotches arranged symmetrically about a median axis; each blotch consisting of two or three confluent black spots.

Simulium, species

Plate 35, fig.4-7

Some specimens of larvae and pupae sent me by Professor V. L. Kellogg, of Stanford University, collected in Santa Cruz mountains, differ from all larvae and pupae so far described.

Larvae. Length 6 to 7mm. Pale brownish gray above, with whitish venter and suture. Head whitish above, the margins brown. The fans with about 30 rays, its longer cilia conspicuous. The secondary fan at the base of the peduncle of the larger fan and usually composed of curved hairs, consists here of coarse, straight hairs. The mandible with apical pair of bristles [fig.6], maxillary palpus with some stout setae, labrum

and hypopharynx as with other species. Labium with its teeth nearly of uniform size. Five or six setae in each of the two ventral rows [fig.7]. Anal papillae were retracted in all the specimens examined; hence I could not determine the number. The pupa has 12 respiratory filaments in each tuft [fig.4]. The abdominal hooks, curved cephalad, are as follows: three or four on ventral surface of each of segments 5, 6 and 7; eight on the dorsal surface of 3, 4 and 5; and a pair of very short, blunt tubercles on the anal segment. The pupal case is shaped as shown on plate 35, figure 5.

Family CULICIDAE

Mosquitos

The Culicidae, or mosquitos, have been studied and described by Dr Howard, Mr Coquillett and others in this country, and by Theobald, Ficalbi, Ross, Nuttall, Shipley, Grassi, and others in Europe in such detail that it is unnecessary to repeat here that which has already been done. I shall therefore content myself with merely giving a synopsis of the generic characters of the larvae, pupae and adults, and describing a few forms such as have come under my notice, together with figures illustrating details of structure. An extensive bibliography is given by Ficalbi in Bullet. d. Soc. Ent. Italiana, 1896, to which the reader is referred. Nuttall and Shipley, in the *Journal of Hygiene*, 1:75, give a bibliography of the more recent work. I shall therefore give only a few references to articles which occur in American literature and a few of the more important of the works of Europeans.

Brief bibliography of the biology of the Culicidae

Coquillett, D. W. (1900) Table to the genera and species in U. S. Dep't Agric. Cir. 40, ser. 2, bul. 25, n. s., and table in Howard's book, Mosquitos (1901).

Dyar, H. (1901) Life History of Uranotaenia, and Descriptions of the Larvae of Two Species of Culex and One of Aedes. N. Y. Ent. Soc. Jour. Dec. 1901.

—— (1902) Illustrations of the Larvae of North American Culicidae. 2, 10:194 and 3, 11:23. N. Y. Ent. Soc. Jour.

—— (1902) Notes on Mosquitoes on Long Island N. Y. Ent. Soc. Wash. Proc. 5:45.

—— (1903) Notes on Mosquitoes in New Hampshire. Ent. Soc. Wash. Proc. 5:140.

Ficalbi, E. (1899) Venti specie di Zanzare. Soc. Ent. Italiana Bul.
—— (1896) Rev. sistematica d. fam. delle Culicidae Europee. Soc. Ent. Ital. Bul.
This contains an extensive bibliography.
Giles, G. M. (1900) Gnats or Mosquitoes; a compilation of the descriptions of the mosquitoes of the world.
Howard, L. O. (1900) U. S. Dep't Agric. Cir. 40, ser.2
—— (1900) U. S. Dep't Agric. Div. Ent. Bul. 25, n. s.
—— (1901) Mosquitoes. McClure, Phillips & Co.
This gives the most complete account we have of the biology of mosquitos.
Meinert, F. (1886) De eucephale Myggelarver. in Vidensk. Selsk. Skr., 6. Raekke, naturvidensk. og math. Afd. 3.4.
Contains about 60 quarto pages and two plates on the biology and structure of the Culicidae.
Nuttall & Shipley (1901) Structure and Biology of Anopheles. Jour. of Hygiene, 1:75.
Osten Sacken, C. R. (1868) Am. Ent. Soc. Trans. 2:47, and Western Diptera, p.191 (1877)
Smith, J. B. (1902) Ent. News. 13:268 and 299.
—— (1902) N. Y. Ent. Soc. Jour. 10:10.
Theobald, F. V. (1901) Monograph of the Culicidae. 2v.
With atlas of 37 colored and 5 photographic plates.
Weissmann, A. (1866) Die Metamorphose der Corethra plumicornis.
Also papers in the reports of the various state experiment stations, by Lugger, Osborn, Herrick, and others.

The mosquitos are small to medium sized flies, characterized by the projecting proboscis (sometimes lobed) and by the plumose antennae of the male. The head is small, round; eyes reniform, and ocelli are wanting. The antennae are threadlike, composed of 15 joints, counting the disklike base; the first joint is thick, the following joints small, round and beset with whorls of hairs, forming in the male a long, dense plumosity; the last two joints in the male are slender and bare, or nearly so. The thorax is ovate, arched, but not projecting over the head, without transverse suture, scutellum narrow; metanotum arched. Abdomen long and narrow, somewhat flattened, composed of eight segments; male genitalia prominent, ovipositor short, legs long and slender, the coxae not elongated; the tarsi long. Wings long and narrow, with numerous veins; the hind margin fringed, the costal vein extending all around the wing, and in all known American forms the veins are covered with scales. Venation as in the figures.

The larvae are known as "wrigglers." The head is fully differentiated and usually has eyes; the mouth is usually thickly

ciliated with hairs, by means of which a current of water is produced that brings little particles of food within reach. At the posterior end of the body is usually a single breathing tube, or there are two tubes opening to the exterior on the dorsal surface of the last segment. The segment behind the head is without prolegs.

The pupae are free swimming, and very active. The breathing tubes are situated at the sides of the thoracic segments. The abdomen terminates in two leaflike appendages, that act as propellers; but in general the pupae remain near the surface, except when disturbed.

KEY TO GENERA OF CULICIDAE OF THE NORTHERN STATES

Larvae

1 The last abdominal segment with a single dorsal breathing tube, through which may be seen a pair of large tracheae.....(4)
Last segment without long breathing tube.....(2)
2 Last segment dorsally with a flat area in which may be seen two spiracles 3
Last segment usually with hooks, no spiracles apparent. Larva transparent, glasslike.....Corethra
3 Large species with the anal segment bladderlike. Mandibles strongly developed [pl.41, fig.1].....Pelorempis, gen. nov.
Species of medium size with anal segment cylindrical...Anopheles
4 Antennae pendant and ending with four large curved spines. Mochlonyx (Europe)
Antennae not pendant.....(5)
5 Antennae fold back against head and terminate in 2 or 3 claws [pl.40] .....Corethrella
Antennae usually only with a few small erect bristles and one or two pointed processes.....(6)
6 With brush of hairs projecting forward from the mouth.....(7)
Brush projects laterad from the mouth. Mandibles long and sharply toothed; large species about 10mm long..... Psorophora (ciliata)
7 No ventral brush on last abdominal segment.....(10)
Last segment with ventral brush.....(8)
8 Anal blood gills dilated; lateral comb of eighth segment a single transverse row of spines with elongated bases; anal segment without hair tufts before barred area..... Stegomyia (fasciata)
Anal blood gills slender.....(9)
9 Anal blood gills sharply pointed, air tube spines with one tooth; lateral comb of eighth segment a few large spines in a single or partly double row.....Aëdes (fuscus)
Not as above in all respects.....Culex

10 With two anal blood gills; the two lateral combs of the air tube wanting. Small species; found in water in the pitcher plant ..... Aedes (smithii)
With four blood gills; with stellate hairs on the abdomen. Small species ..... Uranotaenia (sapphirina)

The southern genera Toxorhynchites, Megarrhinus and Conchyliastes are not included in the above table; their larvae have never been described as far as I am aware.

Pupae

1 Swimming paddles, two pointed lobes [pl.40] ..... Corethrella
Swimming paddles rounded ..... (1a)
1a The respiratory tube of the thorax spindle-shape, pointed at the apex ..... (2)
Tube cylindric or trumpet-shape ..... (3)
2 Both inner and outer margins of the swimming paddles with reinforcing ribs, but without spine at the apex ..... Corethra
Only the middle rib present; last segment short, seventh segment considerably longer than either the sixth or eighth ..... Mochlonyx (Europe)
3 Apex of swimming paddle ending in a small spine ..... (5)
Apex with a few cilia or short hairs ..... (4)
4 Small species 2 or 3 mm in length; last two segments with a thick brush of hairs on each side ..... Aedes (smithii)
Large species, 7 or 8 mm in length ..... Psorophora
5 Large species at least 8 mm in length ..... (6)
Moderate or small sized species ..... (7)
6 Apex of swimming paddle ending in a short, sharp spine ....
Pelorempis gen. nov.
Apparently without a spine (?), with a pair of stellate hairs on the first abdominal segment ..... Psorophora
7 Thoracic breathing tubes much elongated, about 12 times as long as wide. Abdomen with a number of stellate hairs ..
Uranotaenia (sapphirina)
Tubes not elongate ..... (8)
8 Tube about as wide as long ..... Anopheles
Tube longer than wide ..... Culex

Imagos

1 Proboscis short, not much longer than the head ..... (2)
Proboscis elongate, longer than the head and thorax taken together ..... (4a)
2 Metatarsus longer than the following joint ..... (3)
Metatarsus shorter than the following joint. Mochlonyx (Europe)
3 Species less than 4 mm in length; tarsal claws simple ..... (4)
Large species, 10 or more in length; tarsal claws bifid .....
Pelorempis gen. nov.
4 Antennae verticilliate with hairs (i. e. in whorls) ..... Corethra
Antennae wholly covered with hairs, legs densely hairy ....
Corethrella

4a Legs bearing many erect scales. Large species.....Psorophora
Legs without these scales.....(5)
5 Thorax with metallic blue scales; small species; male with but a single curved claw on the middle leg; palpi of both sexes two jointed and short.....Uranotaenia (sapphirina)
Thorax not so marked.....(6)
6 "Hind feet black, their apexes snow white." Male palpi long, in the female short.....Conchylistes
Not as above.....(7)
7 Palpi elongate.....(8)
Palpi short.....(9)
8 The fourth fore tarsal joint shorter than the fifth, about as long as wide. Palpi elongate and pointed.....Culex (males)
Fourth fore tarsal joint longer than wide. Male palpi with enlarged apical joints.....Anopheles
9 Small species with two jointed palpi; the second joint conical..Aedes
Medium sized species, with four jointed palpi, its apical joint cylindrical.....Culex (females)

Of the southern genera, Megarhinus and Toxorhynchites may be known by their strongly curved proboscis and green and bluish colors. Stegomyia resembles Culex, but has the thorax marked with lines of silvery scales.

Subfamily CORETHRINAE

Genus CORETHRA Meigen

This genus together with Corethrella, Mochlonyx and Pelorempis, nov. gen. forms the subfamily Corethrinae, which is distinguished from the remainder of the family by the comparative shortness of the proboscis. There are but 15 or 16 species in the genus, four or five of which occur in North America. The life history of some of the species has long been known. Some of the works on the biology of Corethra are:

1844 Staeger. Naturhist. Tidsskr. I. R. 2. B. 549, 600. Corethra fusca.
1866 Weissmann, Dr A. Die Metamorphose der C. plumicornis.
1884 Herrick, A. Minn. Geol. Nat. Hist. Sur. p.10. C. appendiculata.
1886 Meinert, F. De Eucephale Myggelarver, p.30 to 53. With bibliography.

Generic characters

Usually delicate, moderate sized species of the appearance of a Chironomid, but distinguished by its many veined wing. Head transversely oval, epistome somewhat projecting; pro-

boscis with round labellae, and only one half as long as the incurved, four jointed palpi; antennae 15 jointed, the basal joint disklike, the following joints each thickened at the base, in the male plumose, the last two joints elongated and slender; the eyes crescent-shaped. Thorax highly arched, without suture; scutellum rather small; metathorax prominent. Abdomen long and slender, somewhat flattened, from the base to the middle gradually widening, and again becoming narrower toward the end; hypopygium prominent, the ovipositor projecting. Legs long and slender, the metatarsus longer than the following tarsal joint; claws small and simple. The wing veins and the posterior margin thickly haired; venation as in the figures.

List of the North American species

albipes n. sp. *See* p. 398. Ithaca N. Y.

appendiculata Herrick, Minn. Geol. Nat. Hist. Sur. 1884. p.10. Known only in the larval and pupal stage and may belong to some other genus.

plumicornis Fabricius var. **americana.** (See subsequent pages for synonymy)

Saranac Inn N. Y., Lake Forest Ill., White mountains, N. H. (Slosson), Minnesota (Herrick)

punctipennis Say, Acad. Nat. Sci. Phila. Jour. 1823. 3:16, and Compl. Wr. 2:43. Wiedemann, 1:14. Pennsylvania and New Jersey.

trivittata Loew, Berl. Ent. Zeit. 1862. p.186. (Centur. 2, 1). Maine, California, Alaska.

This is a synonym of punctipennis according to Giles in his work *Gnats or Mosquitoes.*

The larvae of but three North American species are known. To assist in separating the species which may be found later, I have given in the table the characters of some of the European species also.

1 Antennae shortish and with a spine outwardly; anterior part of the head is spiny; club-shaped bodies at the caudal end instead of claws.....appendiculata Herrick
Antennae with four spines.....(2)

2 Ventral comb of the last abdominal segment with a row of brushlike hairs; each consisting of five to seven bristles (European species).....fusca Staeger
Ventral comb consisting of a number of separate feathered hairs [pl.39, fig.6].....(3)

3 The pair of leaflike appendages [pl.39, c. fig.4] lying cephalad of the labrum (*l*), at least one half as wide as long; ventral comb of the last abdominal segment with 25 hairs.....(4)

Appendages over the labrum lanceolate and four or five times as long as wide, ventral comb of last segment with 21 hairs (European) ..... pallida

4 "One of the four antennal bristles markedly shorter than the rest" ..... plumicornis (Europe)

The four antennal bristles of equal length; anal segment with four dorsal hairs..... plumicornis, var. americana

The larva of C. trivittata described by Dyar in N. Y. Ent. Soc. Jour. 10:201 is said to have but 2 dorsal hairs on anal segment.

Pupae

"Extraordinarily elongate abdomen which terminates in two paddlelike appendages, loosely ciliate outwardly"..appendiculata

Abdomen of moderate length, see figure; paddles with short cilia on the inner margin..... plumicornis

Imagos

1 Wings with dark markings..... (2)

Wings unmarked ..... (4)

2 Wings with several cross bands. Length of insect 1.5mm.... Corethrella brakeleyi

Wings with numerous dark spots..... (3)

3 The apex of both femora and the tibiae, and the base also of the tibiae, black, antennae with subfuscous hairs. Length 4.5mm ..... trivittata

Legs punctate with numerous small brown spots. Antennae with yellowish hairs..... punctipennis

4 Yellowish white species; legs white and spotless..... albipes n. sp.

Pale brown or reddish yellow species..... plumicornis

Judging from the description, the larva of appendiculata differs greatly from all the known Corethra larvae, and F. Meinert in *De eucephale Myggelarver* says in regard to its pupa that the figure given by Herrick resembles that of a Chironomid rather than a Corethra. In the same paper Meinert expresses the opinion that fusca is but a darker variety of plumicornis; and attributes the differences in the larva to an error of Staeger, assuming that the latter described some other species.

Corethra appendiculata Herrick

Minn. Geol. Nat. Hist. Sur. 1884. p.19, pl.5.

The adult not bred. Larva as follows:

Form is more slender than plumicornis. The tracheal vessels are of a different form and color, and viscera have obvious differences. . . Shape of the head is slender and attenuated toward insertion of the antennae. Antennae are shortish

and have a spine outwardly. The cuticular appendages have an unusual form, as has the labrum. The anterior part of the head is spiny. The armature of the end of the abdomen is peculiar. The posterior rudimentary appendages are of a different form, and the claws are replaced by club-shaped bodies. A curious appendage below is indicated in the name. The pupa has an extraordinarily elongate abdomen which terminates in two paddle-shaped appendages, loosely ciliate outwardly. From Lake of the Isles near Minneapolis Minn. *Herrick* [*loc. cit.*]

Corethra plumicornis Fabricius

Plate 39

Ent. Syst. 1794. 4:246-58

The following synonymy is according to Schiner, *Fauna Austriaca*, 1864. 2:624.

1776 c r i s t a l l i n a Degeer (Tipula), Ins. 6:149, 20
1787 p i l i c o r n i s Fabricius (Tipula), Mantissa Ins. 2:325-49
1788–93 h a f n i e n s i s Gmelin (Tipula), Syst. Natur. 2826, 108
1794 p l u m i c o r n i s Fabricius, Ent. Syst. 4:246-58
1809 (?) l a t e r a l i s Panzer, Fauna Ger. 109:16
1818 p l u m i c o r n i s Fabricius, Meigen, Syst. Beschr. 1:15. 1
1864 p l u m i c o r n i s Fabricius, Schiner, Fauna Austriaca. 2:624

C. plumicornis, var. americana

Male. Reddish brown; abdomen yellowish; the antennal joints yellow with brown tips, basal joint brown; the hairs pale brown; the front, the upper surface of the proboscis, and the palpal joints brown; the incisures of the latter yellow, the vertex, the cheeks and the underside of the proboscis and neck pale yellow; thorax pale brown above with three dark reddish brown stripes, the middle one divided by a fine, pale brown line; the lateral stripes abbreviated anteriorly, the median one posteriorly; the pectus and the margins of the pleural and jugular sclerites reddish brown; scutellum pale brown, metathorax dark brown; abdominal segments subequal in length except the first and last, which are less than one half of the others. The dorsal surface is brown with pale yellow incisures. The brown coloring is darkest anteriorly, gradually becoming paler caudad, so that the posterior margin of the segment is almost as light in color as the incisure. This is particularly true with segments 3, 4 and 5. On segment 6, 7 and 8 the brown color is almost wanting excepting a triangular lateral spot which is prolonged caudad in a fine line. The outline of this spot, however, is not distinct, but is blended in with the color of the dorsum. A pair of very small pale yellow spots with a narrow brown border are more

or less distinctly visible on each segment. The hypopygium consists of two jointed hooks, is pale brown in color, nearly as long as an abdominal segment [fig.8]. Venter and the legs are pale yellow, the last two or three tarsal joints slightly infuscated. Legs and abdomen densely but delicately haired; wings yellowish, the veins scarcely dark; venation as in figure 10; halteres pure white. Length 5½mm.

Female. Differs from the male in the following particulars. Antennae entirely yellow, basal joint, palpi and upper surface of proboscis with a tinge of brown; frontal spot brown; scutellum with a fine median line and its posterior margin pale yellow; abdomen yellow, dorsal surface with a tinge of brown, specially on the posterior margin. The two little white spots with pale brown margins also present on each segment. Anal segment brown, genitalia yellow, venter, legs, halteres etc. as with the male. Wings as in figure 9. Length 5mm. Described from alcoholic specimens. New Jersey, Illinois, New York, Minnesota.

Larva differs from Meinerts description [*loc. cit.*] of the European p l u m i c o r n i s in the following particulars. The four long bristles of the antennae are of equal length, while in the European form one is distinctly shorter than the rest; the head in all alcoholic specimens is more sharply constricted from the thorax. In Weissmann's figure the spines of the antennae are shown of equal length.

The larva is colorless, in alcoholic specimens pure white; the large eyes, the pair of air sacs in the thorax and in the seventh abdominal segment are black and the tips of the mandibles brown. The head is somewhat elongate, subconical, the antennae pendant [fig.4*a*], each with four long bristles of equal length. Caudad of these are 10 filaments, five on each side of the median line [fig.4*b*]; these are the filaments of the third metamere of Meinert. Then comes the pair of leaflike appendages, appendages of the third metamere of Meinert, [fig.4*c*]; following which is the labrum.

The labrum [fig.4*l*] is an elongate fleshy, fingerlike process, terminating in several tufts of hair. The two ventral tufts each with from 20 to 25 coarse hairs. At the base and somewhat cephalad of the mandibles [fig.4*m*] are the fans [*f*] each consisting of from 18 to 22 long, coarse hairs. The mandibles [*m*] have four or five teeth, two stout spines anteriorly, and a serrate posterior margin. Closing in the lateral posterior margin of the mouth are the maxillae [fig.*x*]; fleshy lobes, each with a long, jointed appendage anteriorly and two short stout spines. At the posterior border of the mouth is the labium [*l*] with

two short spines. The thorax is cylindrical, of greater diameter than the abdomen; the two black air sacs distinctly visible. The abdomen is of circular cross section, tapering gradually toward the caudal end. Segments are subequal in length except the first, which is somewhat shorter; each provided with a few short hair tufts. The black air sacs of the seventh segment are large and distinct. On the ventral surface of the anal segment [fig.6] is a fan of 25 long, feathered hairs, arranged on a keel or ridge. At the apex of this segment are four elongate blood gills and four long, feathered hairs, and near the apex, arranged in a transverse row on each side, is a comb of about 15 small, short hooks, curved cephalad; attached to the base of each hook is a delicate transparent, sickle-shaped blade, with a serrate inner margin; the surface of the blade is covered with transverse ridges, which give it the appearance of a curved pectinate hair, owing to its transparency. The combs are difficult to see. Ventrad of the combs is a pair of large blunt hooks curved cephalad.

The pupa [fig.2] resembles that of Culex, pale yellow in color, the thorax with three brown longitudinal stripes, the middle one divided by a yellow line. Eight abdominal segments are present, the first and eighth shorter than the others, and on each are found a few scattered hairs. Attached to the eighth segment are the swimming paddles [fig.5]; these differ from those of Culex in having, besides the median rib, each margin also supported by a rib. On the inner rib is a row of cilia. The breathing trumpet [fig.20] is spindle-shaped, covered with a close network of pentagonal and hexagonal figures. The small aperture is at the apex.

Corethra punctipennis Say

Acad. Nat. Sci. Phila. Jour. 1823. 3:16. and Compl. Wr. 2:43. Wiedemann. 1828. 1:14

Whitish; wings and feet punctured with fuscous. Inhabits Pennsylvania.

Hair of the antennae yellowish white, the centers of the whorls being fuscous; the shaft of the antennae has a decidedly annulated appearance; eyes black; thorax with three pale yellowish brown abbreviated, broad lines, the middle one originating before and terminating at the center of the disk, the lateral ones originating rather before the middle; feet with numerous small brown punctures; wings with many very obvious brown spots.

Size of C. culiciformis Degeer (i. e. 6mm)

Corethra trivittata Loew

Berl. Ent. Zeit. 1862. Centur. 2, p. 186

Male. Pale yellowish, with three thoracic stripes, the metanotum, fasciae of the abdomen, with apical rings of the femora, and basal and apical rings of the tibiae, fuscous black; the wings with cinereous spots. Length 4.3mm. Wing 5mm.

Pale yellowish, with long, mostly subfuscous pile. Antennae black, annulated, densely verticellate with subfuscous hairs. Dorsum of thorax with three black stripes, the double median one posteriorly, the lateral stripes anteriorly, much shortened. The sides of the scutellum fuscous; metanotum fuscous black; the abdomen fasciate with fuscous. Legs pale yellow; the tarsi from the tip of the first joint pale fuscous; an apical ring on each of the femora and an apical and a basal ring on each tibia is blackish. The wing variegated with some small cinerous black spots. Maine, California, Alaska. *(Osten Sacken)*

This is a synonym of C. p u n c t i p e n n i s according to Giles in *Gnats or Mosquitos.*

The larva and pupa of this species are described by Dr Dyar.[1]

The only apparent difference between this and the larva of p l u m i c o r n i s seems to be that in the former species there are but two hairs on dorsal surface of anal segment while there are four in p l u m i c o r n i s.

Corethra albipes nov. sp.

Female. Entire insect pale yellow in ground color; head and antennae wholly pale yellow: dorsum of thorax with three longitudinal stripes pale buff in color, the lateral ones abbreviated anteriorly, the median one posteriorly, the latter divided longitudinally by a pale yellow line. These stripes all narrowly margined with brown, and on the anterior and outer margins of the lateral stripe are a few tiny black specks. Scutellum with a pale buff posterior margin; pleurae yellow, sparsely sprinkled with small, irregular black specks; abdomen yellowish white beneath, pale buff colored above, lateral margin sparsely sprinkled with small irregular black specks; legs pale yellowish, unspotted, fourth and fifth tarsal joints slightly darkened; claws simple; legs and abdomen covered with long, loose yellow hair; wings uniformly pale yellowish, the veins, the hair on them, and the halteres same color. Venation as in plate 39, figure 11. Length 5½mm. Ithaca N. Y. August 1901.

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[1] N. Y. Ent. Soc. Jour. 10:201.

CORETHRELLA Coquillett

N. Y. Ent. Soc. Jour. 10:191
Plate 40

Through the kindness of Prof. John B. Smith of New Brunswick N. J. from whom I received specimens of larvae, pupae and adults, I have been enabled to make a study of this interesting species, which in the adult stage has already been described under the name of Corethra brakeleyi by Mr D. W. Coquillett.

From Corethra it differs in the following particulars:

In both the male and female the thorax, scutellum, abdomen and legs are sparsely covered with long coarse hairs, many of these being as long as the fore metatarsus. The antenna of the male is thickly covered with long hairs arranged all along the shaft excepting on the apical half of the 13th, and all of the 14th and 15th, which have only short hairs. The 15th or apical joint is slightly enlarged and conical [fig.8]. The antenna of the female has a circlet of a few long hairs at the base of each joint and another irregular circlet of somewhat shorter hairs on the middle of it.

In Corethra, at least in those species with which I am familiar, the male has one circlet of many long hairs at the base of each joint, standing nearly at right angles with the shaft. In the female these hairs are fewer and shorter; the second circlet of hairs wanting. In a balsam mount of Corethrella the 15 antennal joints can easily be counted. The eyes are reniform; the palpi and proboscis are short, the former about twice as long as the latter; the metatarsus is longer than the following joint and the tarsal claws [fig.7] are simple and much curved.

Corethrella brakeleyi Coquillett

Larva. The larva resembles that of Mochlonyx much more closely than that of Corethra; it differs from the former in having the antennae attached near the middle line of the head at the extreme cephalic end, hinged so that they move in a horizontal plane, and normally lie folded back against the side of the head, as shown in figure 1 and 2. The head is transversely oval. The antennae [fig.3] have three long curved spines and

one very short one at the base. Of the longer spines one is somewhat longer than the other two. The dorsal sclerite of the head [fig.1*d*] is somewhat quadrangular in shape, and is provided at its cephalic end with six setae, the median pair being quite small. The lateral sclerites [fig.1 and 2*b*] are nearly hemispherical, with a small black pigment spot on the dorsal surface near the anterior margin; just cephalad of this is a stout seta, laterad of it is a long slender one, and mesad of it a small irregular area of ommatidia. On the middle of each lateral sclerite, arranged in a single transverse row, are about 12 stout spines projecting cephalad, and immediately in front of this row are two or three long slender setae. At the base of each antenna on the frontal sclerite is another seta.

The labrum is a transversely oval piece [fig.4] which is attached at the cephalic margin of the head and hangs flaplike downward and backward over the mouth; its free end provided with two curved, pale yellow spines, between which are several rows of flattened, short, yellow, forked spines. At the base of the labrum are two pairs of rather long, curved setae, and on the center are two pairs of very short, delicate ones.

The mandibles [fig.2 *md*, 5 *md*, and 6] move in a horizontal plane and when folded down are visible only from the ventral aspect. On the inner (mesal) margin near the apical end is a row of seven stout black teeth; on the dorsoapical margin are two stout flattened spines, which, when the long axis of the mandible is parallel to the body, projects mesad nearly at right angles to the long axis of the body. Also on the dorsal surface, a little apicad of the middle are two unequal long and very stout setae; and proximad of these are seven long and one short lanceolate spine attached to a small crescent-shaped basal piece. When viewed from the ventral surface [fig.5] two slender setae may be observed near the lateral margin.

The maxillae [fig.5*mx*] are two lobed. One is of irregular shape, about as long as wide, articulated at its base, with a seta at the apex, and having a small palpus with three or four pointed processes a little laterad of this seta. On the mesal margin are a number of long stout, setae, and long slender hairs. The second lobe [*mx*, *i*], ventrad and mesad of the first, is elongate with a stout seta on the anterior mesal margin. No suture between it and the head sclerite is visible. It may in fact, be a cephalic prolongation of the lateral sclerite of the head. The labium [fig.5*l*] is immovably joined to the ventral sclerite of the head, no separating suture being visible. Its cephalic margin has about 16 stout black teeth, alternating long and short.

The hypopharynx (not shown in the figure), is tonguelike, and lies immediately dorsad of the labium on the floor of the mouth cavity. It is about as wide as the toothed portion of the labium, its anterior margin provided with a fringe of pale, short, fingerlike processes, which barely project beyond the edge of the labium when viewed from below, and is not visible without dissection.

The thorax [fig.1] is transversely oval, not as wide as the head, with the three segments quite distinct. On the lateral margins of each segment are a few tufts of long laterad projecting setae, those on the second and third segments being longer and more numerous than those of the first, and inserted at the tips of fingerlike processes.

The abdomen [fig.1] is nine segmented with long setae on the margins; the setae of the anterior segments being longer than the posterior ones. The tufts of setae of the first and second abdominal segments are inserted on lobular processes like those of the thorax. The eighth segment is shorter than those preceding it; the ninth is slender and cylindric, and makes an angle with the long axis of the body. At its apex are four small blood or tracheal gills, dorsad of which are a pair of long setae, and ventrad, a tuft of them.

Projecting from the caudal margin of the dorsal surface of the eighth segment is the breathing tube, a cylindric tube, as long as, or longer than any abdominal segment, its diameter being less than half its length. At the apex of the tube are several setae, and triangular flaps to cover the aperture.

The color of the head is brown, that of the thorax and abdomen grayish with white incisures. On the dorsal surface of each abdominal segment, surrounded by the whitish field and caudad of the incisure, is an oval, brownish spot. [*See* fig.1]

Pupa. The pupa [fig.10] resembles that of Culex, but differs from it and from other Culicidae known to me, in lacking the broad swimming paddles. In place of them, there are two pointed processes, each with three spines at the apex and a single one laterally near the middle. The breathing trumpet as in Culex, the plane of the margin being quite oblique, but on the rim of the inner side is a little rounded projection. Each abdominal segment has several pairs of setae, the median pair quite stout, the intermediate pair very short and slender and the one or two laterals long and very delicate. In addition to the laterals, there is a longitudinal lateral fringe of very delicate hairs, and the lateral margin is serrate.

Imago. This has already been well described by Mr D. W. Coquillett; and the description is reproduced below.

In addition to the generic characters which have been pointed out, I may say that the wing is heavily fringed with long hairs, and the veins are covered with scales. The venation is shown in fig.9.

Of the life history Professor Smith has given an account in the *Canadian Entomologist* for 1902.

Corethrella brakeleyi Coquillett

Ent. News. March 1902. p.85

Male and female. Dark brown, the antennae, halteres, knees and tarsi yellow, plumosity of male antennae yellow, mesonotum opaque, gray pruinose except three narrow vittae and a few spots near the humeri, hairs of thorax brownish, those of the abdomen yellow, tibiae and tarsi bearing many long hairs; first joint of front tarsi slightly shorter than the tibia; wings whitish hyaline, marked with a brown cross band near one third and two thirds its length, the first one oblique, the second band produced triangularly near middle of its inner side, costal margin on each side of this band strongly tinged with golden yellow, fringe white, marked with a brown spot at posterior end of each cross band and on either side of the extreme wing tip. Length, 1.5 mm.

One male and three females, bred jointly, Aug. 12 to 14, by Mr J. T. Brakeley and Prof. J. P. Smith, Habitat-Lahaway N. J.

PELOREMPIS nov. gen.

Two peculiar larvae were found in a pail of cold spring water at Saranac Inn by Professor Needham, June 1900. One of them was kept till the fly emerged; the other till it had changed into a pupa. Both the larva and adult differ so much from all the species of the Culicidae that a new genus is necessary to contain it.

Female. Large species resembling P s o r o p h o r a in general appearance. Head rounded; occiput strongly developed; proboscis a little longer than the hight of the head with rounded labellae; palpi longer than the proboscis, four jointed (not counting the small basal joint [*see* fig. 10, 11]; the two end joints each longer than the preceding; antennae 15 jointed, the basal joint disklike, the second one short and thick, the rest, including the apical one, small, subequal in length, verticillate with a few hairs of moderate length; eyes kidney-shaped, much cut out around the base of antennae, separated from each other on top of head by only a narrow space; ocelli wanting; thorax

well arched, transverse suture wanting; scutellum narrow, metanotum well developed; abdomen long and narrow, eight segmented besides the anal segment; genitalia inconspicuous; legs long and slender, with fine short hairs, metatarsus nearly as long as the following four joints taken together; claws slender, each with a single tooth on the under side; wings long and slender, extending almost to the margin of the eighth abdominal segment; the margins, and veins except the true cross veins and the first anal, covered with flattened hairs. Venation as in the figure; anal angle obtuse, posterior lobe prominent and rounded. Halteres free.

Pelorempis americana nov. sp.

pl.41

Female. Antennae when flexed downward reaches just a trifle beyond the outstretched palpi. The upper surface of the epistome is brown, yellowish on the sides, the labrum pure white. The labium, which is somewhat prolonged beyond the labrum is brown beneath; this color extends to near the lobelike tip. The lobes are hemispherical and pale yellow, covered with blackish or dark brown bristles. Black hairs cover both the upper surface of epistome and the under surface of labium, and a few bristles on inner eye margin. The front is pale yellow on the lower part, and brown on the upper; the vertex is brown; back of head yellow; palpi brown, the articulations and all of the last two joints yellow, covered with black hairs; antennae reddish brown, the two basal joints and all of third joint except tip, and bases of all the others pale yellow, its hairs black. Thorax yellowish brown; the anterior margin of thorax, a spot on each side of it, four dorsal stripes, and a spot over the root of each wing reddish brown. The dorsal stripes are wide, the median pair only separated by a fine line much abbreviated posteriorly; the lateral stripes abbreviated anteriorly. Scutellum, pleura, and metanotum yellow, the latter with a triangular spot of brown anteriorly, which is prolonged backward into a fine median line; pectus reddish, or reddish brown; thorax and abdomen nearly bare; abdomen eight jointed plus anal segment, yellow, each segment with a reddish brown fascia which covers the posterior third of the segment, excepting its extreme edge. The anterior margin of each fascia produced forward at the middle and the sides till the brown color nearly reaches the anterior margin of the segment. The anal appendage consists of four rounded, inconspicuous pieces. The venter is paler than the yellow of the dorsum. Legs yellow, a few small spots on the coxae, the tip of all femora, base and tips of all tibiae and the tarsi except the

basal one half of the metatarsus are reddish brown. The brown of the tarsi seems to be due to the presence of the numerous brown hairs rather than to ground color. Tarsal claws reddish brown; all tibiae with a single delicate yellow spur; wings with brownish clouds, one on each of the three vein forks, a longer one covering the cross veins; an irregular one covers the bases of the veins and a cloud following the length of the cubitus. All veins with scales except the true cross veins and the first anal; venation as in figures. Halteres yellow with brown margins on knob. Length 10mm.

Larva. The empty larval skin from which the figures on plate 41 were made is in a very good state of preservation excepting for a longitudinal break on the dorsal surface of the head and thorax, and the distorted condition of the skin of the thorax and abdomen. In figure 1 [pl.41] the thorax and abdomen are somewhat diagrammatic and the proportions may not be exact owing to the above mentioned fact; the head and the anal appendages however are drawn to scale. The larva resembles Corethra and Mochlonyx (a European genus) in the form of the antennae, which are elongate, and provided with stout spines, set at an angle with the long axis of the antennae [fig.1, 2]. The spines are three in number, wherein this genus differs from Corethra and Mochlonyx which have four. The mandibles are more highly developed than in the other genera of this family, and possess two stout curved teeth, besides several smaller teeth and spines (ventral view figure 3m; dorsal view figure 5). The fanlike brush of hairs so conspicuous in Anopheles, Culex, etc. and somewhat also in Corethra and Mochlonyx seems to be wanting entirely here. The labrum [fig.6] is trapezoidal in shape, its anterior margin being straight. On its upper surface it is provided with two stout bristles, besides 10 smaller ones arranged as shown in the figure. Two converging rows of scales are present, these reaching the extreme front margin. One of these scales is shown in figure 9. The anterior margin is somewhat ciliated; and on the under surface are two converging rows of transverse chitinous ridges, five or six ridges to each row. The maxillae [fig.3*x*] resembles those of Corethra, its anterior margin provided with numerous scales and hairs. The scales resemble those of the labrum [fig.9]. At the base near the articulation of the mandible is a wartlike prominence with four short spines; this may possibly be the maxillary palpus. Toward the inner margin is a single stout bristle. The epipharynx and hypopharynx are wanting in this specimen, probably torn away when the larval skin was shed. The labium [fig.3*l*] is somewhat triangular in shape, its lateral and

anterior margins serrate, six teeth being present in the lateral and 10 in the anterior row. The shape of the head resembles that of Mochlonyx, but with the mandibles more prominent; it is reddish brown in color and heavily chitinized. No eye spots are visible in the specimen.

The thorax is provided with about eight tufts of feathered hairs on each side, the abdomen with about seven pairs. It is possible that several of the more caudad of what is here termed thoracic tufts may belong to the first few abdominal segments. The anal segment and appendages resemble those of Anopheles. The dorsal breathing apparatus [fig.1, 4] shown somewhat flexed sidewise in figure 1, is star-shaped with four radiating pointed lobes, between the anterior pair of which open the two spiracles [fig.4*s*]. At the apex of each of the posterior pair is a single stout bristle. Between the spiracles is a pair of crescent-shaped chitinized brown patches, laterad of which is a pair of small bristles, and another pair is cephalad. The anal segment is ellipsoidal with a row of 31 tufts of hairs, each tuft composed of several hairs; at the caudal end are four (or six) very small blood gills, besides a single large tuft of hairs.

Pupa [fig.8]. This resembles that of Culex and Anopheles. The coloring is like that described for the adult. The breathing trumpets are somewhat less flaring at the top than Anopheles, but more so than is usual with Culex. On the posterior margin of the first segment of the abdomen are three feathered hairs on each side; 2, 3, 4, and 5 each have two feathered hairs on each side plus some scattered hairs; 6, 7 and 8 each have three or four simple hairs on each side. The swimming paddles [fig.7] have a single median rib ending in a short, stout spine.

The venation of the adult wing clearly locates this genus with the Culicidae; the form of the proboscis proves its relationship with Corethra and Mochlonyx, forming with these the subfamily Corethrinae.

Subfamily CULICINAE

This subfamily is characterized by the possession of the typical long proboscis, which is longer than the head and thorax taken together.

Genus ANOPHELES Meigen

Pl. 42, fig. 1–7, 9–11

Moderate sized species resembling the ordinary mosquito. Head rounded, occiput prominent; proboscis bristlelike and projecting forward, longer than the antennae; the palpi in both sexes as long as the proboscis, four jointed, the two end joints

taken together shorter than the one preceding, in the male long haired; antennae 15 jointed, the basal joint disklike, the following ones small, in the male long haired, in the female short and sparsely haired; eyes somewhat reniform, the ocelli wanting; the mesothorax rather long and somewhat pointed in front, and without transverse suture; scutellum narrow, the metathorax rather prominent; abdomen long and slender, eight jointed, the genitalia small and inconspicuous; legs long and slender, nearly bare; wings with the veins and the margin thickly haired, the venation as in the figure.

The females may be easily distinguished from Culex by the presence of palpi about as long as the proboscis; the male may be distinguished by the following characters. In Anopheles the last two palpal joints are much thicker than the first and second, and spatulate in form, while in Culex they are the same in diameter, the last one more or less pointed; further, in all the species which I have examined, a stump of a vein extends back into the basal cell from the base of the radial sector and another from base of R_{4+5}; this venation seems to be rare in Culex; in our species also the fourth tarsal joint of the fore leg in Anopheles is more than twice as long as wide, while in Culex it is no longer than wide.

Anopheles punctipennis Say

Acad. Nat. Sci. Phila. Jour. 1823. v.3 and Compl. Wr. 2:39.1

Male. Brown, covered with cinereous hair; head, antennae including the long hairs, palpi and proboscis uniform brown; thorax dark brown with three longitudinal cinereous stripes, the middle one divided by a fine brown line covered with sparse yellow hairs; pleura and scutellum, cinereous brown; metanotum and abdomen dark brown, the latter with the basal two thirds and the extreme posterior edge of each segment with a cinereous bloom, and covered with brown erect hairs; genitalia of moderate size, consisting of two, two jointed appendages, the joints of about equal length, the second one slender, curved and pointed. On the ventral aspect is a sharp caudad projecting spur [fig.10]. Legs uniformly brown except the knees and the extreme tips of the tibiae, which are yellow. The fore tarsal claws have each a long toothed claw and a very short simple one. The feet of the middle and hind legs each have two simple

claws. Wings with brown scales, a quadrangular patch of yellow scales just proximad of the fork of R_2 and R_3 covering a short section of both R_1 and the costal vein; an oblique patch at tip of R_1, crossing the media, leaving the tips black of all excepting R_1; a few scattered pale yellow patches of scales elsewhere; and the posterior margin brown scaled, with patches of white ones at the tip of Cu_2. Halteres pale yellow at base, the knob infuscated. Length $3\frac{1}{2}$ to 5 mm, exclusive of antennae and wings.

Female. Brown, as with the male; abdomen more uniformly brown, covered with nearly erect, fine, yellow hairs; scutellum and metathorax with a fine dark line; tarsal claws all simple; wings as with the male but wider in proportion to the length; venation as in figure 5; the basal section of R_{4+5} distad of the R-M cross vein, as the male. Everything else as in the male. Length 4 to 6 mm.

Larva. Three regions may be distinguished in the larva, viz the head, thorax and abdomen. The head is rounded, brown in color, and completely chitinized; the eyes are situated laterally and seem to be of two kinds; one is compact and more or less circular in outline, the other, visible only in older larvae, is a crescentlike body compounded of ommatidia-primordia of adult eyes. On a level with the eyes and cephalad of them are the antennae, and a trifle caudad of the base of these on the dorsal surface, arranged in a transverse row, are six feathered hairs. These are not placed on a band of pigment as is said to be the case with maculipennis. Between the base of the antennae and the base of the maxillary palpi, on a chitinized prominence, is a conspicuous branched hair. Near the tip on the dorsal surface of the labrum are two simple hairs projecting forward; these are more caudad than in maculipennis. Back of the transverse row of feathered hairs is another transverse row composed of four small feathered hairs; between the latter are usually nine more or less distinct pigment spots, the largest in the center, the others arranged around it. At the extreme cephalic end, at each side of the labrum, is a dense brush of brown hairs; another smaller brush is at the tip of the labrum and on the ventral surface of the labrum are several tiny tufts of hairs just in front of the mouth opening. The piece which carries the tufts on the sides of the labrum is called the scutum of the second metamere or clypeus. The antennae are two jointed, the first short and apparently immovable; the second elongate, free, bearing two rather long spines and two short ones, and a six branched hair, (Nuttall shows four in maculipennis). About one third of its length from the

base is a branched hair. The mandibles forming the sides of the mouth opening; each possess two stout, elongate, and four or five shorter black teeth at the apex, a little below which is a ridge with a serrated edge (not shown by Nuttall). Overhanging the teeth are three scythe-shaped rays, and between their bases and the base of the teeth are a number of brown hairs and one or more curved spines with a serrated inner edge. Projecting inward from about the middle of the mandible is a fan of hairs, and usually also several branched hairs are to be found on the outer margin.

The maxillae (first pair) each consist of a quadrangular piece with curved hairs on the cephalic, and straight ones on the inner margin. On the inner cephalic angle are several stout setae; the palpus is a conical process covered with short hairs, with three elongate spines at the tip connected by a web, and several shorter bristles. Laterally, near the tip, is a hair having four branches, each branch with several twigs. The maxillae together with the labium (underlip of Meinert) form the floor of the mouth cavity. The labium is a chitinized piece with seven to nine teeth on the cephalic margin, forming a continuation of the ventral wall of the head, to which it is articulated [pl.42, fig.3]. A small toothed piece, in outline resembling the labium but with fewer teeth, lying just inside of the latter, is what I take to be the hypopharynx (not shown in figure). Meinert in his work on Myggelarver [pl.11, fig.24], shows both of these, the one slightly displaced in dissection. The thorax is rounded, its segments obliterated. Twelve long feathered hairs stand on the dorsal surface besides some smaller ones and several simple hairs [pl.42, fig.2]. The nine-segmented abdomen is provided with a number of feathered hairs besides many bristles. The first two segments each have two long feathered hairs on each side, the third has one (in all specimens examined); the fourth and fifth on each side, each with three or four simple hairs united at the base, the sixth, seventh and eighth, with but one or two, besides these there are two or three short feathered hairs, and several short, simple ones on each side of each segment. The only difference which I have observed in the hairy armature of the abdomen of this species and *maculipennis* [figured by Nuttall, *Journal of Hygiene*, v.1, pl.2, fig.4] is the presence of one or two more of the long, simple hairs on the sides of segments 4 and 5. The "palmate hairs" on the sides of 3 to 7 mentioned by Nuttall are also present in this species [pl.42, fig.4*a*]. On the posterior half of the dorsal surface of the eighth segment is the complex respiratory apparatus which surrounds the two stigmata [pl.42, fig.1]. In front of the two stigmata is a brown,

apparently chitinized plate, which may be folded over them, flaplike; on each side of them is a conical papilla with a few bristles at the apex. These are not figured by Nuttall though figured by Meinert for C. maculipennis. Prolonged backward are two lobes (somewhat pressed apart in the figure), and between these is an elongate, flattened, checkered plate forming the floor of the area. On the ventral surface of each posterior lobe are a branched hair and a few bristles. On either side of this structure is a comb, its teeth projecting caudad. Each comb has about seven long teeth, and between each of these are from one to four shorter ones. The cylindric ninth segment, when the animal lies horizontal, its dorsal surface uppermost, is suspended obliquely below the breathing apparatus, its dorsal surface covered with a chitinized plate or saddle. From its ventral surface, attached to a keellike process, is a fanlike arrangement consisting of two rows, each with nine branched hairs. On the dorsal surface are four hairs, the two anterior ones are feathered, the two posterior (and also a little more lateral) are branched. The anus is at the extremity of the segment, and surrounded by the four white papillae or blood gills.

Pupa. Resembles that of the other Culicidae. "When viewed sidewise, the pupa of Anopheles presents a comparatively smooth outline, but in Culex the edge where each tergum joins posteriorly the soft integument which unites it with the succeeding tergum stands out as a ridge, and the dorsal outline presents a series of salient angles" [Nuttall & Shipley]. "Respiratory trumpets are not so broad terminally in Culex as in Anopheles" [Howard]. [pl.42, fig.11]

Anopheles maculipennis Meigen

1818 A. maculipennis Meigen, Syst. Beschr. 1:11 Compl. Wr. 1:241
1823 A. quadrimaculatus Say, Long's Exp. Apx. p.356.
1828 A. quadrimaculatus Say, Wiedemann, Aussereur. Zweiflüg. 1:13

Female. Brown. Wings with four fuscous spots. Head, antennae, proboscis and palpi pale brown. Thorax dull cinereous brown, covered with sparse yellow hairs; with two brown lines nearly contiguous posteriorly; pleura cinereous; scutellum and metanotum brown, the latter bare. Abdomen brown, rather thickly covered with suberect yellow hairs, ventral surface paler. Legs brown, the femora pale, knees and tips of tibiae pale yellow. Wings hyaline, the veins with pale brown scales, a spot of darker scales at the base of the radial sector, one at the fork of R_1 and R_2, one at the fork of the media, and a

fourth at the cross veins. Venation as in figure 9. The basal section of R_{4+5} proximad of the R–M cross vein. Halteres pale, with a fuscous knob. Nuttall and Shipley state and also show in the figure which they give of the wing of maculipennis that the subcosta extends almost to the tip of the wing. In all specimens of females which I have examined this is not the case with the American form. Should this difference be found constant, Say's name of quadrimaculatus must be restored.

Larva. According to the description and figure given by Nuttall and Shipley [1901], it differs from that of punctipennis in the following particulars. The six feathered hairs arranged on the dorsal surface of the head are placed on a transverse band of pigment. On the dorsal surface of the labrum are two simple hairs projecting forward; these are more cephalad than in punctipennis. The pigment spots arranged symmetrically about the median line, so conspicuous in punctipennis, are wanting in this species. At the end of the second antennal joint is a four branched hair according to the figure given by Nuttall, whereas this hair has six branches in punctipennis. The mandibles show some differences. The only differences in the hairy armature of the abdomen which I have observed in punctipennis, in comparing with the description and figure of Nuttall of maculipennis, is the presence of one or two more of the long, simple hairs of segments 4 and 5 in the former species.

Pupa. Agrees in all particulars with the description given for punctipennis. A comparison of fresh specimens of both species will be necessary to reveal differences.

Genus PSOROPHORA Desvoidy

Large species which resemble Culex in having a straight proboscis; the male has palpi as long as the proboscis, those of the female being short. It differs from Culex in having many nearly erect scales on the legs.

Two species have been described from the United States. They may be distinguished by the characters given in the key below.

Length 6mm exclusive of the probocis; cell 2d R much longer than the cell M; body black, the humeri yellow, pleura and sides of the mesonotum bearing many appressed white scales, abdomen on the upper side covered with appressed violet purple scales, those on the first segment and a few at the hind angles of some of the other segments white. (Hartsville S. C.) Canadian Ent., 1901, p.258.....howardii Coquillett

Length 9 or 10 mm; cell 2d R only a little longer than M [pl.42, fig.8]. Thorax striped; body brown; legs yellow, with dark brown or black erect scales. United States, widely distributed. Wiedemann, Aussereur. Zweiflüg. 1828. 1:13....
ciliata Fabricius

The life history of P. ciliata is given by Howard in the *Canadian Entomologist* for 1900 and also in his work on mosquitos. Of the larva he says, "from Culex it differs in having a longer breathing tube, longer and more pointed blood gills, and the hair fringe on the under side of the anal segment much longer and denser. The jaws are sharply toothed and very long." From the figure it appears also that the mouth brushes project laterally and not forward as in Culex. Figures are given in both of the papers of Howard, mentioned above.

Genus CULEX Linne

The species of this genus are the ordinary mosquitos. In most respects they are like the species of the genus Anopheles, but differ from them in that the male alone possesses the elongate palpi, in the female these are very short; the mesothorax is more arched and more nearly vertical in front; and the hypopygium of the male is quite conspicuous, whereas with Anopheles it is small and inconspicuous. In other respects, including the biting habits of the female, just like Anopheles.

It may be added, that in all species of Culex examined it was found that the fourth tarsal joint of the fore leg in the male is only about as long as it is broad; and that the last joint of the palpus is pointed. The wing venation also appears to present differences from Anopheles, in that the spur at the base of R_{4+5} is usually wanting in Culex.

Larva. The larvae are usually known as wrigglers, and characterized by their rapid wriggling movements, their wormlike bodies and disproportionately large heads with a pair of prominent eyes, an enlarged thorax, and their possessing on the dorsal surface of the eighth segment an elongate breathing tube. The eggs of some species are laid on the surface of the pond or pool in an oblong mass or boat, which in the warmer spring or summer weather hatches within a day or less. The small transparent larvae are extremely active from birth. They come to the surface to breathe, the elongate breathing tube of the last segment being in contact with the surface film, the cephalic end hanging obliquely downward. When disturbed the larva descends to the

bottom, jerking its body rapidly from one side to the other. It appears to be heavier than water, for sometimes it may be seen to descend quietly, apparently without motion; though, in order to rise, it "wriggles" to the surface. In the full grown larva the head, more or less rounded, is large, usually nearly as wide as the thorax from which it is separated by a narrow neck. The antenna, which arises from a slight prominence a little in front of the eye, consists of a single elongate shaft, with a short terminal joint (which appears to be annulated), several bristles and jointed hairs at the end of the first joint, and a tuft of hairs at about the middle of the shaft. Projecting from the middle of the anterior end of the head is a complex arrangement of hairs which spring from two folded ridges one on each side of the ventral surface of the labrum [pl.43, fig.5]. The length of the hairs varies with the species. Meinert [*De Eucephale Myggelarver*] speaks of this as a whorl, or rotatory organ, as he believes that it is by the vibrations of these bristles that the food is directed into the mouth. The greater part of the upper surface of the head is formed of a single plate which Meinert [*loc. cit.*] calls the dorsal surface of the third metamere. In front of this is a short, broad plate ("scutum of the second metamere," Meinert, called the clypeus by Giles [*Mosquitoes*]. [pl.44, fig.8*c*]

Attached to the anterior margin of the latter is the round prominence covered with hairs; this is the labium [pl.44, fig.8] or "scutum of the first metamere" [Meinert]. If the front part of the dorsal surface of the head be removed and turned ventral surface uppermost [pl.43, fig.5], the two fans or rotatory organs [fig.5*f*] may be seen, mesad and caudad of which are two tufts of hair projecting caudad. Between the latter is a rounded process on which are from two to four spines. This process together with the two tufts of hair, I believe to be the epipharynx[*e*].

The eyes are large and placed laterally, behind which and lying close to, may usually be seen a small ocellus. On each side of the mouth opening, ventrad of the fans, are the mandibles; stout, quadrangular pieces with a number of sharp teeth, at the cephalic end with two stout spines curved mesad, a row of hairs arranged on a ridge or keel overhanging the teeth, and another row of long hairs arranged on the posterior margin [pl.45, fig.1, 2]. A fingerlike process with hair at its apex projects mesad from the mesocaudal margin [fig. 2*a*]. Ventrad of the mandibles are the maxillae [pl.43, fig.4*x*]. These are also indicated by dotted lines under the mandibles [*m*] on right hand side, the figure being a dorsal view of the lower half of the head.

the dorsal surface having been removed. The maxillae are fleshy ovoid processes with a longitudinal row or terminal tuft of hairs, besides the long, loose hairs on the mesal surface. Attached to the base and projecting laterad is the palpus with its four or five terminal spurs or papillae. Forming the floor of the mouth cavity, and attached to the anterior edge or coalescent with the sclerite which forms the lower surface of the head is the labium [pl.43, fig.4*l*]; a more or less triangular or semicircular piece with a toothed margin. The ventral surface and margin is usually fringed with setae.

The hypopharynx is a toothed piece resembling the lower jawbone of a mammal, and lies tonguelike on the floor of the mouth cavity [pl. 43, fig.4*h* and pl.44, fig.6]. It is quite small and, being loosely attached, is easily torn away in dissection, hence somewhat difficult to find. Attached to the posterior edge of the hypopharynx [pl.44, fig.5], and lying obliquely, with reference to the frontal plane, but perpendicular to the sagittal plane, is an elliptic flat ring. This ring is compound, made up of four lamellae in close contact, so that it appears at first sight as a single ring; the surface of the lamellae is striated and fringed on the inner margin with long cilia. A portion of the front end of this ring is shown on plate 44, figure 5*s*. It appears to be the anterior margin of the gullet, and may perhaps act as a kind of sieve on which the food particles swept in by the rotatory fans, are caught. A second toothed piece [pl.44, fig.5*t*] lies dorsad of the anterior lobe of the hypopharynx, and is probably a part of it.

The thorax is circular in outline, and wider than the head. In the full grown larva the sutures separating the three thoracic segments can not be distinguished. On its surface are tufts of long bristles, longer usually than those on the rest of the body. These bristles are feathered, though not so much so as in Anopheles. The hairs appear to act as balancers. In addition to these hairs are a number of smaller, shorter tufts.

The abdomen is five or six times as long as the thorax, but of much smaller diameter; consisting of nine segments counting the anal segment. The segments are subequal in length excepting the first, eighth and ninth, which are frequently shorter. On the lateral margins are tufts of a few long hairs besides a few shorter ones, the arrangement of which may give specific characters, though, owing to the ease with which they fall off in alcoholic specimens, they must be used as distinctive characters with some caution. Projecting from the dorsal surface, near the posterior margin of the eighth segment, is a long, more or less cylindric tube, into which the two main respiratory

trunks can easily be followed, and are seen to open at its extremity. On each side of this tube is a single row of short spines, and at the base is a tuft of short hairs. On each side of the eighth segment is a comb composed of a variable number of short spines [pl.45, fig.6]; the tip of each spine is sometimes covered with short hairs.

The ninth abdominal segment, usually shorter than the others and of less diameter, contains the rectum and the anus, being almost at the extremity of the body. Around the opening are two pairs of delicate, elongate lobes. These are tracheal or blood gills. Immediately cephalad of these are dense tufts of long hairs, the position and arrangement of which are variable with the species. Usually also, dorsad of the blood gills are a variable number of long bristles.

Pupa. The pupa differs from those of the other genera of this family less than does the larva. It is characterized by its bulky, oval, laterally compressed anterior part, made up of the head, thorax and its appendages, and a posterior part, consisting of the abdomen with its swimming paddles [pl.43, fig.7]. The length of pupal life in all observed specimens was about four days. During this time the pupa would remain quietly floating with its thorax nearly vertical, its abdomen bent under, unless disturbed, when it propels itself to the bottom by means of the violent contractions of the abdomen, after the fashion of a crawfish. The specific gravity apparently being less than water, however, it requires a constant effort to remain at the bottom.

The head is bent down under the thorax, the antennae folded back arcuate and lying along its sides; the legs folded up in a sinuate fashion; the wings extending downward and backward from the sides. Near the highest point of the thorax, the pupa occupying its usual vertical position [pl.43, fig.7], are the two breathing trumpets, elongate, subcylindrical tubes, open and somewhat flaring at the top [pl.44, fig.11]. On the dorsal surface near the posterior margin of the thorax, are usually a pair of stellate hairs. The abdomen has eight segments, subequal in length except the first and last two, which are shorter, and on the posterior margins of which are a few tufts of branched hairs. Attached to the last segment is a pair of broad swimming paddles, each reinforced by a stout longitudinal rib, and ending in a single short spine. Between the paddles is a furcate fleshy process in which are contained the genitalia of the inclosed imago. The shape of this fleshy process differs with the sexes, and perhaps also with the species. The pupae of all the species I have examined resemble one another so closely that I have been unable to distinguish them. It appears however that there

are slight constant differences in the form of the air trumpet and in the number and arrangement of the abdominal hairs. Fresh specimens should however be examined in order to characterize them correctly.

The arrangement of the bristles on the abdomen is about the same in all the species examined. On the dorsal surface of the first abdominal segment are a pair of conspicuous stellate hairs, the remaining segments each have about three pairs of lateral discal hairs, and two pairs of small, branched, marginal ones; one of the marginal pairs of the eighth segment being many branched. Besides these there are usually a few scattered hairs.

Much has been written about the species of this genus, but the fact that most of the older descriptions are inadequate renders the synonymy much involved. Coquillett has done the best and most recent work on the North American species; and the reader is referred to his papers published by the United States Department of Agriculture, or, better still, to his table given in Howard's book on mosquitos, for the determination of the adults. In the last mentioned work will be found a most complete description of the life history of several species of mosquitos. The recent work of Theobald is a monograph of the Culicidae of the world.

Dr Dyar has recently published in the Proceedings of the Washington Entomological Society (1902 and 1903) and in the Journal of the New York Entomological Society (1902 and 1903) the descriptions of the larvae of a number of species of Culex, together with keys for their identification. The following key is adapted from one given by him, modified to include species more recently described.

KEY TO SPECIES OF CULEX LARVAE

1 Without a longitudinal row of spines on the air tube; hair tufts of anal segment confined to the barred area; seventh segment with a round dorsal plate incised anteriorly..... *signifer* Coq.

With a longitudinal row of spines or hair on the air tube.....(2)

2 Air tube at least four times as long as its breadth at the base .....(3)

Air tube less than three times as long as broad.....(9)

3 Antennae with hair tuft beyond the middle of the joint.....(4)

The antennal tuft at or before the middle.....(8)

4 Air tube six or more times as long as broad; antennae white banded .....(5)

Air tube 4 or 5 times as long as broad.....(9)

5 Tube concave, the tip wider than the terminal portion. Spines of tube mostly with a single basal branch.....territ ans

Tube regularly tapered, smallest at the tip. Spines of the tube 3 to 4 branched.....nigritulus

6 Anal segment without hair tufts anteriorly of the transversely barred area.....(7)

Anal segment with hair tufts on the ventral line up to the base.....dyari

7 Lateral comb of the eighth segment a patch of spines; tube brown.....pipiens

Lateral comb a row of bars; air tube black.....melanurus

8 Apex of the labium rounded [pl.44, fig.1]. Antennae whitish on basal half.....restuans

Apex of labium pointed [pl.45].....cantans

9 Lateral comb of the eighth segment a patch of small spines three or more rows deep.....(10)

Lateral comb a few spines on a single or partly double row.....(13)

10 Anal segment with hair tufts before the barred area.....(11)

Anal segment without tufts before the barred area.....(12)

11 The spines of the air tube prolonged into setae; tube about three times as long as wide; the antennal tuft is at the middle of the joint.....consobrinus

The air tube with spines, anal segment broadly plated..canadensis

12 Antenna with a small tuft a little before middle of the joint. Air tube about two and a half times as long as wide; lateral comb about three rows deep.....bimaculatus

Antenna with a single inconspicuous hair instead of a tuft. Air tube not over twice as long as wide; lateral comb about five rows deep.....atropalpus

13 Anal segment with hair tufts before barred area.....(14)

Anal segment without tufts before barred area.....(16)

14 Comb of eighth segment of separate nearly simple spines, the spines of the air tube each with three teeth.....sylvestris

Comb of eighth segment either toothed or digitate.....(15)

15 Comb of eight segment composed of spines with finely digitately divided tips; antenna with a single long seta instead of a tuft.....triseriatus

Comb of conspicuously toothed spines, joined on a weak basal plate. Antenna with a small hair tuft.....jamaicensis

16 Comb of eighth segment of nearly simple, thorn-shaped teeth.....sollicitans

Comb of eighth segment of pectinated spines in an incomplete double row.....taeniorhynchus

The pupae resemble each other so closely that I have been unable as yet to find satisfactory characters to distinguish them.

Culex restuans Theobald

Plate 44

Monogr. of Culicidae, II:142

Male. Length 4.5 to 5 mm. Uniformly fuscous. Palpi as in plate 44, figure 12. The thorax is apparently marked with stripes; bases of the abdominal segments with yellow scales; bases of the femora and the tips of the tibiae yellow. Tarsal claws of the fore and middle legs unequal, each with a tooth, hind claws simple. Male genitalia resemble those shown on plate 43, figure 41; but the apex of the terminal claw is sinuous, and with a tiny hooked appendage. Wings hyaline, with fuscous scales. Venation as in figure 9. Halteres pale.

Female. Palpi as shown in figure 13. All tarsal claws simple. Venation of the wing as in figure 10. In other respects like the male.

Described from alcoholic specimens obtained from Professor Needham. Bred. Saranac Inn N. Y., July 21, 1900.

Larva. Length 7 to 8mm. The head is round, widest at the eyes, slightly wider than long, with six moderately long hair tufts in a transverse row immediately back of the antennae; the antennae slender, uniform, and brown in color but paler at the base. On the shaft is a tuft of 10 to 12 long hairs, a little below the middle, and at the tip are three slender and one stout spine and the stout apical joint. Rotatory fans normal. The mandibles have immediately above the teeth a long, stout spine with a serrated inner margin. The maxillae possess a pair of moderately long dorsal spines. The cephalic margin of the labium is arcuate, with about 23 teeth, besides three on each lateral margin [pl.44, fig.1]. The epipharynx is of the usual shape, though its lateral spines are somewhat longer than the median [fig.6]. The hypopharynx has a toothed margin and eight spines, four on each side, two lateral lobed processes each with six fingerlike projections and a median piece with a lobed margin [fig.5]. The labrum [fig.8] is hairy as usual, the clypeus [fig.8c] with two stout spines on its dorsal surface. On the gula are two trifid hairs. The thorax is rounded, and at the base of the larger tufts of hair are spurlike processes with four or five teeth projecting cephalad. The long, loosely feathered hair tufts of the thorax consist of the usual anterior transverse row, and the two lateral groups [fig.3]. The hairs of the abdomen are arranged in tufts of about equal length, though there are fewer hairs in the posterior ones; air tube brown, of moderate length, the row of lateral spines on it each with from 15 to 20 spines; caudad of which are a few long hairs. The lateral combs of the eighth

abdominal segment with 30 to 32 teeth arranged in about three irregular rows. Caudad of this comb is a tuft of nine feathered hairs, and dorsad and ventrad of it are several small bristles. On the dorsal margin of the ninth segment are three or four long bristles, and on the apical third of the ventral surface is a brush of long hairs consisting of from nine to 12 tufts. In most specimens the blood or tracheal gills are long, extending beyond the tip of the breathing tube.

Pupa. The breathing trumpet [fig.11] is somewhat widened at the top, about five times as long as wide, its apical margin oblique. On the most posterior of the thoracic sclerites are three pairs of short, stout, branched hairs; on the dorsal surface of the first abdominal segment, are the usual pair of stellate hairs; the remaining segments each have about three pairs of lateral discal hairs and two pairs of small branched marginal ones, one of the marginal pairs on the eighth segment being many branched.

Culex pipiens Linnaeus

Plate 43

Male. Length 4mm. Antennal joints grayish white, the tips black, the long hairs brown; proboscis and palpi pale fuscous, the latter darker at the tip with long, dark brown hairs; occiput with yellowish hairs; dorsum of thorax yellowish brown, with five indistinct, darker brown stripes, on each of which is a row of a few black or brown bristles, elsewhere covered with yellow scales; pleura metanotum and scutellum yellowish brown, the last slightly darker, with a few long brownish hairs; abdomen long haired, segments fuscous, at the base rather widely fasciated with yellow scales; ventral surface paler fuscous; genitalia yellowish, not very prominent [fig.11]; legs fuscous, quite pale on the coxae and base of femora, gradually becoming darker distally, the tarsi being quite dark; the knees and extreme tip of tibiae, yellowish. The fore and middle pairs of claws unequal, the longer one inside, each claw with a distinct tooth [fig.8]. The hind claws simple. Wings hyaline, scales fuscous [fig.10]. Halteres pale.

Female. Length 4mm. Antennae, proboscis and palpi uniformly fuscous; abdomen fuscous, with a very narrow basal fascia of yellow scales on each segment; ventral surface paler; femora with basal half and flexor surface yellow, gradually becoming darker distally, tibiae and tarsi as with the male. All tarsal claws simple [fig.9]. Wings with fuscous scales. Venation as in figure 12. All else as with the male. Bred specimens. July 18, Aug. 31, and Sep. 7, 1901. Ithaca N. Y.

Larva. Length 7 to 8 mm. The head is nearly circular in outline, color pale fuscous, with six moderately long tufts of hair on

the dorsal surface, the lateral ones near the base of the antennae, the others more caudad [fig.2]; eyes large; antennae flattened, wider on the portion below the hair tuft, which is composed of 20 to 30 loosely feathered, long hairs on the side at about two thirds its length from the base; its apex with four slender and one stout bristle besides the short apical joint. The rotatory fan [fig.5*f*], labrum [*lr*] and epipharynx [*e*] normal; clypeus with the usual pair of setae; the mandibles with a long, stout, curved, pale brown spine with a serrate inner margin, projecting beyond the black teeth. A pair of small spines are found on the dorsal surface of the maxillae, and a small seta near the apex [fig.4*x*]. The cephalic margin of the labium [fig.4*l*] is elliptic, the median tooth longer than the others, and the hypopharynx [*h*] is of the usual shape [pl.44, fig.5]. The thorax is rounded; arranged on the dorsal surface in a transverse row near the cephalic margin are 10 or 12 equally spaced tufts of long hairs, the median tuft largest. A little caudad of the middle line, near the lateral margin are six or eight long hairs in an irregular transverse row, and on the lateral posterior margin, are two tufts of five or six short hairs each. The outline of the abdomen presents a sinuous margin, the segments being somewhat constricted at the incisures. On the prominence of each side of the segments are three or four moderately long hairs. The lateral combs of the eighth segment consist of a patch of about 50 spines. Caudad of the lateral comb is a tuft of about eight feathered hairs, and dorsad and ventrad of this is another smaller tuft. The ninth segment has five or six long setae on the dorsocaudal margin, 13 or 14 branched hairs of about six branches each on the caudal third of the ventral surface and four rather long sharply pointed blood or tracheal gills. The breathing tube is rather long, with from 10 to 15 serrate spines in a longitudinal row on each side, and on the ventral surface are three pairs of long and several short tufts of hair.

Pupa [fig.6, 7]. The breathing trumpet is comparatively long, widest at the apical third, its opening extending downward on one side to almost the middle. On the abdomen are the usual bristles, those on the lateral margin being larger toward the caudal end. Swimming paddles are of the usual shape.

Culex cantans Meigen

Plate 45

Syst. Beschr. 1818. 1:6, 2:6

1848 C. stimulans Walker. List etc. Synonymy according to Coquillett.

Male. Length 7 or 8 mm. Antennae with long fuscous hair; proboscis and palpi yellowish brown, the latter

with a band of dark scales near the base; joints dark; occiput with yellowish white scales; thorax with a black or brown ground, thickly covered with short golden yellow hairs, with five narrow longitudinal stripes of white scales. The lateral stripes are not parallel with the intermediate pair, but, starting anteriorly quite close together, diverge rapidly and end near the base of the wing. The white stripes are frequently quite indistinct, in which case the thorax might be described as having two rather wide yellowish stripes; pleura and scutellum with whitish hairs; metanotum brown and bare; each segment of the abdomen dorsally with its anterior third covered with short, whitish scales, which extend also in a narrow more or less broken line along the lateral margin. Posterior part of the segments is black with an occasional paler scale, particularly on the posterior margin. The last segment is nearly covered with white scales. Venter with yellowish white scales, which are rather thickly interspersed with long, pale brownish hairs; hypopygium prominent, black; flexor surface of the femora white, extensor surface sprinkled with brown; flexor surface of the tibiae and metatarsi yellow, extensor surface brown; tarsi black with the basal third or fourth white. Claws all with a tooth on the underside of each. One claw of the middle foot is much longer than the other and is sinuous in outline [fig.10]. Wings hyaline with blackish scales and a sprinkling of paler ones. Fourth tarsal joint of the male short. Venation as in figure 9. Halteres white.

Female. Antennae pale brown; proboscis fuscous; venter of abdomen without long hairs; genitalia black; anterior femora and tibiae brownish, with scattered whitish hairs; fore and middle tarsal claws with a single tooth, hind pair simple. In all other respects like the male.

Larva. Length 11 to 12 mm to the tip of the breathing tube. The head is dark brown, antennae with two slender and two stout apical setae and a short terminal joint; at a little below the middle is a tuft of about eight hairs, and on the shaft are a number of short, thick spines. The color of the antennae is a uniform dark brown. The rotatory fans are rather long, the individual hairs are noticeably pectinate at the tip. The mandibles, maxillae and labrum are normal, the latter apparently without the pair of dorsal spines, possessing a long, thick tuft of hair apically and a comparatively large palpus. At the base of the palpus on the triangular sclerite is a stout spine, and caudad and mesad of this is another, placed close to the suture which separates the lateral from the ventral sclerites of the head. The labium resembles that of C. triseriatus but

is somewhat more rounded, the middle tooth prominent. The thorax is transversely oval, with three or four rather short, stout setae on the cephalolateral margins, caudad of which and near the lateral margin is a tuft of short hairs; on the middle of the lateral margins are two tufts of feathered hairs, and caudad of this is another pair. The abdominal segments are slightly constricted at the incisures; the first segment has three or four long feathered hairs on each side; the rest of the segments each have about two on each side, besides some short, scattered ones. The lateral combs of the eighth segment have 35 or 40 teeth each. The ninth segment has a tuft of about 16 dorsocaudal bristles, one of them longer than the rest, and on its ventral surface are about 16 tufts, the first four somewhat separated from the rest and from each other. The dorsal surface of the segment is covered by a brown chitinized saddle. The tracheal or blood gills are of moderate length. The breathing tube is long, about four or five times as long as wide; with 20 or 25 lateral serrate spines in the longitudinal row, the basal four or five being smaller than the rest.

Pupa. The pupa greatly resembles those of the other species. The breathing trumpet widens at about one third the distance from the base, its open end only slightly oblique.

Described from a number of bred specimens. May 1901. Ithaca N. Y.

Culex sylvestris Theobald

Monogr. Culicidae. 1:406

This species will fall in the same couplet with C. s t i m u l a n s Walker (=C. c a n t a n s Meigen), in the key given in Dr Howard's book on mosquitos (1901 ed.). It is apparently not uncommon and has probably heretofore been confused with the above mentioned species. It greatly resembles C. c a n t a n s, it also agrees fairly well with the descriptions of C. v e x a n s Meigen and with Walker's description of C. s t i m u l a n s. From the first it differs in having (in *unrubbed*, bred specimens) an unmarked thorax, and in having only the immediate bases of the tarsal joints white. The male also has the long claw of the middle foot slightly curved but not sinuous [*compare* pl.45, fig.10 and pl.40, fig.11]. From C. s t i m u l a n s it differs in having the posterior fork cell wider and shorter than the anterior, while in s t i m u l a n s, according to Giles, they are "of about equal length and breadth." From both

of the foregoing and from C. v e x a n s also, the male differs in having a white band on the middle of the long second joint of the palpus. In spite of the tooth on the underside of the hind claws I believe my identification is correct.

Male. Length 5mm. Antennae with long fulvous hairs, proboscis and palpi dark brown, the latter with a white band on the middle of the long second joint, and the bases of the third and fourth joints white. The occiput with golden yellow hairs and patches of blackish and whitish scales; dorsum of the thorax with a black or brown ground uniformly covered with golden yellow hairs, the posterior margin and the scutellum with a fringe of longer yellow hairs; metanotum light grayish brown, bare; pleura brown with whitish scales.

Each segment of the abdomen dorsally with its anterior fourth covered with short white scales; posterior part of the segments black slightly produced forward in the center and the posterior margins of the next to the last whitish; the last one wholly black; genitalia brown, the apical joint slender with a spine near its apex [pl.40, fig.12]; venter pale brown with whitish scales; entire abdomen with long, erect pale brown hairs; femora brownish, the bases and the flexor surface of the middle and hind pairs and sometimes the front pair also, white; tibiae and tarsi brownish black, flexor surface paler; the immediate base (about one eighth of the length) of each joint of the tarsi yellowish white. The hind legs with erect, yellow setae. All tarsal claws with a tooth on the under side of each. The long claw of the middle foot as shown in figure 12. The venation is about as that shown for C. c a n t a n s, though the posterior cross vein is not oblique. Halteres yellowish white.

Female. Differs from the male only as follows. Antennae brown, basal two or three joints yellow; abdomen marked like the male, but the long hairs are only on the posterior margin of each segment; genitalia black, consisting of two fingerlike lobes; venter yellow with white scales, posterior margin of the segments black. Tarsal claws like the male.

Described from bred specimens.

Larva. The larva resembles that of C. c a n t a n s. The mandibles are like those shown on plate 45, though the teeth are more blunt; the maxilla is like that shown on the same plate, though the palpus is rather shorter than shown here, and there are two lateral spines. The labium is pointed, and the antenna has a tuft of bristles near the middle. The teeth on the sides of the eighth segment are arranged in one irregular row. The spines of the longitudinal row of the breathing tube each have

two or three short teeth near the base, the two or three elongate distal spines being separate from the others and from each other. Breathing tube about two and one half times longer than wide. The setae of the ninth segment extend forward from the barred area.

Pupa. The plane of the margin of the breathing trumpet makes about a 30° angle with its long axis. Specimens taken July 10, 1902, Ithaca N. Y.

Culex triseriatus Say

Plate 46

Acad. Sci. Phila. Jour. 3:12. 4 Compl. Wr. 2:40; Wiedemann, 1:11, 12

Female. Length 4½mm. Antennae uniformly grayish, the large basal joint yellowish, the joints of the flagellum verticillate, with a few long, black hairs, besides which the shaft is covered with sparse grayish white, downy hair; proboscis fuscous, including its base and the epistome. Palpi one fourth as long as proboscis, cylindric. Occiput covered with silvery white scales; dorsum of thorax with a very broad black stripe, widened posteriorly, where it covers the space to the base of the wing excepting a spot of white scales in the middle line on a line with the bases of the wing; scutellum and metanotum black; the sides of the anterior part of the dorsum, and the pleura, covered with white scales; abdomen covered with deep black scales. The anterior margin of the dorsal surface of the segments are fasciate with dark brown scales, and the anterior margin of all segments on the ventral surface fasciate with white scales. These latter fasciae extend to the sides and their extremities are just visible on the dorsal aspect. The last segment is yellow, genitalia black; the legs black, the coxae, the flexor surface of all the femora, the bases of the first and second pairs, the basal two thirds of the hind pair, and all the knees, white; tarsi sometimes dark brown. The fore and middle pair of tarsal claws each with a tooth, those of the hind pair simple. Wings smoky, the scales black, those on the posterior margin brown. Venation as in figure 7. Halteres white.

Male. Antennae wanting. Like the female in all respects excepting as follows. The black dorsal stripe slightly narrower; the long palpi are black, hypopygium prominent, the front tarsal claws of unequal size, one long and curved, the other shorter and nearly straight; both with a single tooth on the underside, the middle claws each with a tooth, hind ones simple. Described from specimens bred July 1901. Ithaca N. Y.

Larva. Length 7 to 8 mm. Head [fig.3] is round, in color brown; in the transverse row between the bases of the anten-

nae are six tufts of hairs, the median pair short; caudad of these is one pair of long setae, and directly caudad of each eye is a single one. The antennae [fig.1] have three or four apical bristles besides the usual small terminal joint, and a little distad of the middle is a single long seta. Labrum, rotatory fan and maxillae normal, the two dorsal spines of the latter rather longer than in C. pipiens and the papillae on the mesal surface are more prominent. The spines of the epipharynx as in C. pipiens, but the lateral ones shorter than the median pair. The stout apical spine of the mandible [fig.2] does not project beyond the tip of the teeth. The labium [fig.4], is triangular with 19 teeth, hair on its ventral surface, and caudad of the transverse suture are two pairs of setae. The hypopharynx, shown somewhat diagrammatically in figure 6, has a number of sharp teeth besides two lateral lobes with fingerlike processes (not shown in the figure). On the dorsal surface, along the cephalic margin of the thorax, are six or eight hair tufts, all rather short except the lateral ones, which are of moderate length; on the middle and on the posterior end of the lateral margin are two long tufts. Near the caudal margin are two stellate hairs. Each abdominal segment has, besides the long lateral tuft, four short dorsal tufts and a few short lateral and ventral hairs. The lateral comb of the eighth segment is composed of about eight spines arranged in one irregular row; the ninth segment but little longer than wide, is provided with a dorsocaudal tuft of 10 or 12 hairs, a ventral row of about 10 tufts, each tuft with four or five hairs. The blood or tracheal gills are comparatively short. The breathing tube is short, about twice as long as wide, with a lateral longitudinal row of 18 to 20 spines, at the caudal end of which is a single hair tuft.

Pupa. The pupa does not appear to differ from C. cantans. The air trumpet is widened at the top, the plane of the margin of the aperture makes about 45° with the longitudinal axis. Bred specimens. July 1901. Ithaca N. Y.

Genus AEDES Meigen

Small, brownish or blackish gray species closely resembling Culex, differing only in that both sexes have very short palpi. According to Van der Wulp, the palpi, though short as in the female of Culex, are not cylindric as in the latter genus, but conical or pointed, and consist of two joints only. But two species of adults are known from the United States.

A. fuscus O. S., Western Diptera. 1877. p.191. Cambridge Mass.
A. smithii Coquillett, Canadian Ent. 1901. p.260. New Jersey.

Imagines

These two species may be distinguished as follows:

With cross bands of yellowish scales at the bases of the abdominal segments..... A. fuscus O. S.
Without these bands.....A. smithii Coquillett

Larvae

With four anal blood gills..... fuscus
With two anal blood gills..... smithii

Aedes fuscus Osten Sacken

The larva is described by Dr Dyar in the Journal of the New York Entomological Society for 1902, page 197. This larva differs from that of A. smithii in having four long narrowly taper-pointed blood gills instead of but two. The antenna has a tuft of hair a little before the middle; the breathing tube is about three times as long as wide; its spines are single toothed. The ninth segment has tufts before the barred area; the lateral combs of the eighth segment consist of a single irregular row of rather course spines.

"The pupa is normal, its air tube cylindrical, slightly bent but not widened into funnel shape."

Aedes smithii Coquillett

Plate 47, fig. 1-6

The adult is described by Coquillett in the *Canadian Entomologist*, 1901. Of the life history Prof. J. B. Smith has discovered the following:[1]

"The female Aedes lay their eggs in the newest leaves of the pitcher plants (Sarracenia), and do not always wait for water to collect in them. Of the specimens of larvae which he had taken during the winter the last one changed to the pupal state about Sep. 9; thus being in a larval state since the preceding October. He thought that there were about three broods, and that the different specimens vary in their time of appearing, which seems to give one continuous season."

The larva has already been well described by Dr Dyar, in New York Entomological Society Journal, December 1901, page 178, plate 10, figure 1. It greatly resembles the larva of Culex, this species differing from the known members of that

[1] Ent. News. 1901. p.254. *See also* N. Y. Ent. Soc. Jour. March 1902.

genus in the following particulars. The mandible has but one large bristle or curved spine at the apex (in all specimens examined); the papillae of the maxillae are elongate and sharply pointed; and the blood gills at the posterior end are only two in number.

The characters of the species are as follows: Head rounded, somewhat flattened; eyes very small, round, and black; rotatory fan conspicuous; antennae slender, uniformly pale in color, the lateral tuft represented by a single seta, its terminal appendages short, consisting of two or three slender setae, a blunt spine and the usual short terminal joint [pl.47, fig.1]. The mandibles [fig.2*m*] are shaped like those of Culex but appear to have but one stout, curved seta at the apex; the bearded process caudad of the teeth has a stouter base than in Culex; maxillae [fig.2*x*] elongate, pointed papillae and several terminal setae besides the usual long hairs. The labrum resembles that of Culex, the clypeus with a pair of rather elongate blunt spines. Epipharynx as in Culex, though with but two instead of four spines. The labium triangular with a long central tooth and nine teeth on each side of this [fig.2*l*]. The gula is apparently without setae. On the dorsal surface of the head between the bases of the antennae in a transverse row are four small setae, and caudad of each of the two inner ones is another. Thorax quadrate, wider than long, lateral margin sinuous; dorsal hairs short, those of the three lateral groups long; abdomen slender, segments subequal in length, the long lateral hairs about of equal length, those on the anterior segment, four to six in number, diminishing in number caudad, so that on the last two segments there are usually but two on each side. The dorsocaudal and ventrocaudal tufts short and composed of two or three hairs. The lateral combs of the eighth segment consist of 15 to 20 stout teeth arranged in a single somewhat irregular transverse row. The air tubes rather short, about three times as long as its greatest diameter; with four rows, each with five or six long setae [fig.6]. The two longitudinal rows of teeth which are present in Culex are entirely wanting. The anal segment is short, with two inflated translucent blood gills and with dorsocaudal, laterocaudal and ventrocaudal tufts of long hairs; the ventral brush wanting.

The pupa has the posterior margin of the swimming paddles ciliate with short hairs instead of terminating with a single bristle as it does in Culex. Near the anterior margin of the thorax is a pair of long setae, caudad of which are two pairs of short forked hairs. The breathing trumpet [fig.4] is like

Culex, the plane of the margin being about at right angles with the long axis of the tube. On the dorsum of thorax is a pair of short forked hairs just caudad of the trumpet: on the metathorax is a transverse row of slender setae, and caudad of the base of the posterior margin of the wing are five or six rather long setae. The two stellate hairs on the first abdominal segment are very conspicuous. The rest of the segments each with a few subdorsal hairs: on the posterior end of the lateral margin of segments 4, 5 and 6 is a single long one, and on 7 and 8 a conspicuous fan of hairs [fig.5]. The swimming paddles are rather small and with cilia on posterior margin. The thorax in mature specimens is dark brown, the abdomen paler.

Described from specimens kindly furnished by Prof. John B. Smith.

Genus URANOTAENIA Arribalzaga

This genus possesses in most respects the same characteristics as Culex and Aedes; it differs from Culex however in having short palpi in both sexes, agreeing in this with Aedes, but differs from the latter in having violet blue scales on the thorax. The palpi of both sexes are two jointed, the basal joint globular, nearly as large as the basal joint of the antennae, the apical joint small, conical and pointed; differing thus from the cylindric palpi of the female Culex.

Uranotaenia sapphirina Osten Sacken (Aedes)

Plate 46, fig. 8-15

Am. Ent. Soc. Trans. 2:47

"Wings unspotted; abdomen dorsally brownish, thorax tawny brown with a median dorsal, and three lines on the pleurae, metallic blue; tarsi brownish, unbanded." Description of Osten Sacken. 1868. 2:47. "Fuscous, the frons, a median thoracic line and stripes on pleurae metallic blue; bases of coxae and femora pale; apexes of the femora and tibiae snowy. Front blackish, with a metallic blue reflection along the eyes, specially in the middle. Antennae blackish, scapus tawny; those of the male apparently 15 jointed (13 plus two, flagellum with 12 beautifully bearded joints; a 13th elongated, linear joint has some scattered hairs, but no beard like the preceding ones. Proboscis long, reaching in the male if bent backward, to about the middle of the abdomen; rather conspicuously incrassated at the tip; perhaps still longer in the female (abdomen of my female injured); thorax brownish, tawny, darker above, paler on the pleurae; a metallic blue longitudinal line along the middle of the thorax reaches the scutellum; three similar marks on the pleurae, the upper of which is in the shape of a short line run-

ning from base of wing toward the head. Abdomen brownish above, paler below; knob of halteres brown, stem pale. Feet brownish paler at the base; a snow-white dot on the upper side of tip of femora and of tibiae; when looked at very obliquely, these white dots appear slightly pale bluish, and the tibiae and tarsi likewise show a faint bluish reflection. Wings clothed with brown scales, but showing in an oblique light numerous blue reflections, especially a stripe near the basis between the third and fourth longitudinal veins. Obs.—In female specimen the scales are rubbed on the feet; therefore appear pale tawny; still, white dots are distinctly visible. Length 3mm. Wing 3mm. Habitat United States, Washington D. C., Brooklyn N. Y."

To the above I may add that in well preserved specimens the abdomen has a very narrow, pale posterior margin, and that the female also possesses the white spot at the tip of the femora, rather faint, and at tip of tibia very distinct. The tarsal claws of both male and female are simple, the middle tarsi of the male with but a single large strongly curved claw [fig.15]. The claws of the hind legs small and but slightly curved. Wing venation as in the figures [fig.13 female, fig.14 male]. The hypopygium of the male, moderate sized with the jointed appendage slender and curved up at the tip [fig.12]; its ventral tooth simple.

[Pl.46, fig.8-15]. The larva and pupa, and the life history of this species are described by Dr Dyar.[1] According to the figures and description given by Dr Dyar, this species differs from the known members of the genus Culex in the following particulars: "Antennae moderate, divergent [fig.10]. The hairs of the thorax and abdomen [fig.8] black, the thoracic ones equal, long; those of the first and second abdominal segment also long; but the rest very short and inconspicuous, stellate. The lateral comb [fig.9] of the eighth abdominal segment is a large plate with a row of stout teeth on the posterior edge . . . air tube rather short, not longer than two segments, widened at the tip by four distinct, flattened teeth, as long as the width of the tube; last segment moderate, with the usual four anal fingers (blood gills). Pupa essentially as in Culex. . . Segments dorsally

[1] N. Y. Ent. Soc. Jour. 1901. 9:179.

tufted with stellate hairs and some small tufts about the eyes and between the prothoracic air tubes. Tubes long, slender, uniform in width, not flared, but slightly bent in the middle, about 12 times as long as wide."

Family DIXIDAE

Dixa midges

Plate 48

These little flies closely resemble mosquitos in size and form: but may easily be distinguished from them by the venation of their wings, and in that the veins are not furnished with scales [pl.48, fig.8]. The antennae are about 15 jointed, and differ but slightly in the two sexes; the legs are long and slender; and the caudal end of the abdomen of the male is enlarged. The family includes only a single genus, Dixa. The flies appear to be rare in America; at any rate are rarely observed.

The larvae of several European species are known. The following is the first published description of the larva of an American species, as far as I am aware.

Dixa modesta nov. sp.

Mr Henshaw kindly compared this species with Loew's types in the Cambridge Museum and he found that it differs from all of them.

Male and female. Brown, dorsum of the thorax between the dark stripes yellowish; scutellum, middle and hind coxae, and tip of the abdomen either yellowish or pale brown. Length 2 to 2.5 mm.

Head dark brown, including palpi, antennae, and proboscis. Thorax including the pleura, metanotum, and sternum, brown; dorsum yellow with three wide brown stripes, scutellum yellowish or pale brown. Abdomen dark brown or black, venter a little paler, last segment yellowish, tip of genitalia black. Legs brown, middle and hind coxae yellowish, and the basal portion of the femora more or less yellowish brown, the tarsi and the tips of the tibiae almost black. Wings hyaline very faintly cinereous, veins fuscous, cross vein not clouded; the peduncle of the Cubitus about as long or but little longer than the fork. Venation as shown in figure 10.

Described from a number of captured and bred specimens. April and October 1902. Ithaca N. Y.

Larva. The larva is found in pond water or in slow flowing streams. It is almost always bent double in the shape of a letter U [fig.5], so that the head and tail come close together; the bend being at the sixth segment. When kept in a tumbler of water, it will lie on the side of the glass with its body above the water level; its head and tail toward the water. It appears however that it is still within the surface film. Its general color is a pale fuscous with black head and appendages. The body consists of three thoracic and eight abdominal plus the anal segment. The head [fig.1] is somewhat quadrangular in shape, with the antennae at the anterior lateral margins. On the dorsal head sclerite are three pairs of setae arranged as in figure 6; and on the ventral surface are also three pairs besides a smaller one at the base of each antenna, as shown in figure 1. The antennae are slender, slightly curved, and deep brown in color, with numerous sharp, distad projecting tubercles or spines. The labrum is attached to the cephalic margin of the dorsal sclerite [fig.6] and hangs flaplike over the mouth. The margin is heavily fringed with dense tufts of hair which appear to act as retatory organs. Ventrad of this are the mandibles [fig.2], short and stout, each with a curved spine at its cephalic end, a pair of curved setae on its outer (lateral) margin, and a row of fine, curved hairs overhanging the two short, sharp teeth in its inner (mesal) margin. The maxillae are ventrad of the mandibles, and are well developed. At the apical end of each are a few fine, curved hairs [fig.3], and on its outer surface are short, scattered hairs. Its palpus [fig.3*p*] greatly resembles the antenna, but is a little smaller. On its basal joint is a stout seta. The labium is semicircular in outline, with hairs on its apical margin, but apparently without teeth.

On the dorsal surface of the first thoracic segment are a few long, cephalad projecting setae, and a few shorter ones on each of the following thoracic and abdominal segments. The first two abdominal segments each have anteriorly on the ventral surface a pair of short prolegs with rows of short, curved bristles [fig.5*c*]. The ventral posterior margin of each of the eighth, ninth, and tenth body segments (fifth, sixth and seventh abdominal segments) is a fringe of stout caudad projecting bristles [fig.5*b*].

The appendages of the last segment of the abdomen superficially resemble those of Anopheles. The spiracles open on the dorsal surface [fig.7*s*], and surrounding each of these and extending laterad is a leaflike plate with a ciliated margin. Immediately cephalad of these is a transverse row of six short branched hairs. Extending caudad are two long, dark brown

fingerlike lobes, each with a marginal fringe composed of a single row of stout setae; and lying between these is a third, cylindric, nearly black in color, provided apically with three pairs of long black setae, and a short, pale yellow terminal joint [fig.7]. The middle lobe does not extend quite so far caudad as do the lateral lobes, differing in this respect from the described (European) species. It is a little more than twice as long as wide. Of the four small respiratory gills figured by Meinert in *Pe cucephale Myggelarver* nothing is to be seen in the specimen from which the drawing was made, though they are present in specimens discovered later. Caudad of the spiracles and lying on the dorsal surface is a triangular chitinized plate, the rounded vertex pointing cephalad, the basal angles each provided with a single short seta [fig.7*p*]. On the ventral surface, at the base of each of the long lateral lobes, is a short, semicircular lobe with a marginal row of short, black spines [fig.7*a*]. On each side of the middle line and caudad of the small lobes is a black ridge or keel with two black setae, the longer one projecting caudad, the shorter one projecting laterad; and extending transversely between the bases of these setae is a matted fringe of fine, pale yellow caudad projecting hairs.

Pupa. The pupa [fig. 1] is pale fuscous. The single observed specimen assumed a nearly circular position, its caudal end nearly touching its head, and remaining motionless on the side of the glass above the water film. Normally a Dixa pupa rests on its side, and according to Meinert it may thrive either in or out of water. The length of pupal life is about three days. No setae were observed on any portion of its body. The breathing trumpets are short, with widely flaring conical mouths. There are eight abdominal segments besides the anal one. The anal segment has two long, pointed lobes with very finely serrate margin and a few short, terminal hairs.

The larva on which this description is based, was found in Ithaca N. Y. in a slow flowing stream Ap. 11, 1902; it pupated Ap. 18, and emerged three days later. A number of specimens were found in October.

KEY TO SPECIES OF DIXA

In order to facilitate identification, the following key is offered, which must however be used with caution, as it is in part compiled from descriptions.

1 Species having both the proboscis and the scutellum yellow.....(2)
Having either proboscis or scutellum black.....(4)

2 Knob of the halteres black. With the head, palpi, base of the antennae, thorax, venter and the legs except the tip of the femora, yellow. Length 2.7mm. Berl. Ent. Zeit. 1863. Centur. 3, p.1. District of Columbia.....marginata Loew

Knob of the halteres yellow. With the head, antennae, palpi (except the base), thoracic stripes and part of the legs brown or black.....(3)

3 Cross vein with cloud. "The peduncle of veins R_1 and R_2 very short." Female. Length 2.7mm. Berl. Ent. Zeit. 1863. Centur. 3, p.4. Maryland and New Jersey (Johnson).....notata Loew

Cross vein not clouded. Peduncle of this vein as usual; a little shorter in the male than in female. Length 2.5mm. Berl. Ent. Zeit. 1863. Centur. 3, p.3. New York and Ithaca N. Y. (=? D. recens Walker).....terna Loew

4 Species having both the proboscis and the knob of the halteres black.....(5)

Having proboscis and halteres of different colors.....(6)

5 Thorax with yellow space between the dark dorsal stripes. Ithaca N. Y.....modesta n. sp.

Without yellow on dorsum. Blackish species. Lower part of the pleura, sometimes scutellum and metanotum, coxae and base of the femora, and stem of the halteres yellow. Male and female. Length 2.5 mm. Berl. Ent. Zeit. 1863. Centur. 3, p.5. New York.....fusca Loew

6 With yellow rostrum; halteres with a fuscous head. Head, palpi, antennae, thoracic and pleural stripe, abdomen and tip of femora wholly black; tarsi fuscous. Length 3 mm. Male. Berl. Ent. Zeit. 1872. Centur. 10, p.1. Texas.venosa Loew

With black proboscis; halteres yellowish; palpi and proboscis and tips of femora and tibia black.....(7)

7 Antennae and scutellum black; pleura and metanotum black; and tarsi and abdomen fuscous black; halteres sordidly yellow. Male 2.7 mm. Berl. Ent. Ziet. 1863. Centur. 3, p.3. New York, (=D. nova Walker?).....centralis Loew

Antennae yellow at the base, flagellum pale fuscous, scutellum fuscous testaceous; tip of posterior tibiae thickened. Metanotum black with yellow margin; abdomen shining cinereous black; tarsi black toward the tip. Male and female. Length 4.2 mm. Berl. Ent. Zeit. 1869. Centur. 8, p.1. Massachusetts.....clavata Loew

Family CHIRONOMIDAE

This family is exceedingly rich in species. Owing to the fact that the life history of comparatively few is known, it is difficult to give a key even to the genera of the larvae and pupae. The Chironomidae may be divided into three groups, the first

containing Chironomus and allied genera, the second containing Tanypus and some others, and the third, Ceratopogon etc. Besides this, there are a few aberrant genera which can not well be placed in any of the above mentioned groups.

The bibliography of the biologic literature is rather extensive, specially for European species; and I will therefore give only that which may be of particular interest to the American reader.

Brauer, F. Syst. Studien auf Grundlage der Dipteren-Larven nebst einer Zusammenstellung von Beispielen aus der Literatur ueber dieselben und Beschreibungen neuer Formen. Denkschr. d. k. zoo. bot. Gesell. Wien. 1883. 47:1-100, pl.1-5

Fries. Monographia Tanyporum Sueciae. 1824

Gercke. Verh. Ver. Hamburg. 1877. 4:6, and 1880. v.6

Kieffer, J. J. Allgemeine Zeitsch. f. Ent. Aug. 1901. Ceratopogon and Wulpiella

Meinert, Fr. De eucephale Muggelarver. With extensive bibliography. 1886

Miall & Hammond. The Harlequin Fly. On the Life History and Anatomy of Chironomus dorsalis. With bibliography. 1901

Packard, A. S. On Insects Inhabiting Salt Water. Am. Jour. Sci. no. 2. 1871. Species of Ceratopogon (nec Tanypus)

—— Essex Inst. Proc. 6:42. Chironomus oceanicus

Pettit, R. H. Mich. Acad. Sci. 1900. p.110. A Leaf-mining Chironomus

Osborn, H. Iowa Exp. Sta. Bul. 32. Chironomus Larva

Smith, Sidney. United States Fish. Com. v.2, Rep't for 1872 and 1873. Sketch of the Invertebrate Fauna of Lake Superior. Larva of Chironomus

The Chironomidae are gnatlike flies of slender form, the males conspicuous for their plumose antennae. They may be distinguished from mosquitos, which they resemble very much, by the costal vein not being continuous on the posterior side of the wing. The larvae are soft skinned, wormlike, and usually aquatic, though some are terrestrial. These midges are often seen, specially in the early spring or in the autumn, in immense swarms, dancing in the air. For a more complete characterization of the family the reader is referred to Comstock's *Manual for the Study of Insects* or to Williston's *Manual of the North American Diptera.*

Gercke, in *Verh. Ver. Hamburg*, 1878, 4:225, distinguishes the larvae of Chironomus and Tanypus thus: "All Chironomus larvae have a cylindrical body, a short oval head; the smaller spe-

cies yellowish in color, often colorless; the larger ones often a deep red. All Chironomus larvae build a cylindrical, gelatinous, or silky case, in which they usually are hidden. The larvae of Tanypus possess a distinctly segmented, somewhat flattened body, with long conical anal prolegs, an elongate triangular head, with distinct eye spots. They do not appear to build a larval case." Those Ceratopogon which in the adult state do not possess hairy wings, have aquatic larvae. These are very elongate, snakelike in form, with a conical head, no thoracic or caudal appendages, save sometimes a few bristles at the tip of the last segment.

The pupa of Chironomus usually lies hidden in the larval case, keeping the water surrounding it in circulation by the undulating motion of the abdomen. The pupa of Tanypus is active and resembles that of Culex. The pupa of Ceratopogon is more elongate than that of Tanypus, and is not active, but floats nearly motionless, with its body in a vertical position.

For determining the genera of the imagos, the table given by Williston in his *Manual of the North American Diptera* is most useful.

Chironomus (sens. str.) sp.

Plate 49

A large number of larvae and pupae were taken from the stomachs of brook trout, as has been described by Professor Needham in this bulletin. Many specimens were examined and all found to belong to the same species. The species evidently being of great importance as fish food, it is desirable that it may in the future be recognized, and therefore I herewith describe it. Many characters here given apply to the genus as well.

Body slender, 12 segmented, full grown specimens about 18mm in length. Occasionally, still living specimens were found within the fish stomachs; these possessed the brilliant red color so characteristic of certain Chironomid larvae. At the anterior end of the first segment and at the posterior end of the 12th are pairs of prolegs. The head is small, dark brown, heavily chitinized, a little longer than wide. The sclerites of the head consist of a dorsal, ventral and two lateral plates, besides a number of smaller ones. The dorsal sclerite resembles that shown on plate 50, figure 1; but there are three pairs of bristles

near the suture on the dorsal plate, the anterior pair quite close to the anterior margin [pl. 49, fig.8], and laterad of the posterior pair, lying close to the suture, but on the lateral plate is another seta. The median plate carries the labrum [*lr*, fig.8], which hangs flaplike in front of the mouth and may be bent backward, and on its under surface are three pairs of setae. Attached to the labrum on its ventral surface is the epipharynx [fig.3*e*]. This is a complex structure attached at its anterior margin, its free margin projecting ventrad and caudad. On its surface are a number of spines, its margin is serrate and provided with three pairs of small serrate teeth. In addition to this is a pair of long, chitinized, sickle-shaped processes. The shape and the arrangement of the setae are as shown in figure 3. The lateral plates bear two pairs of rudimentary eyes (pigment spots), as well as the antennae and the jaws. The antennae [fig.2] are situated on the anterior end of the lateral plates; they are small, consisting of a comparatively long basal joint, on which are two terminal pieces, one four jointed, the other somewhat shorter and simple. The mandibles, situated ventrad of the antennae are stout and with a four or five toothed apical margin. Near the base, overhanging the teeth, is a brush of hair [fig.5 and fig.8*m*]. The mandibles are articulated in such a manner that they move in an oblique plane, striking the labium [fig.8*l* and fig.5*l*]. The labium is attached, or rather coalescent with the front margin of the ventral sclerite of the head, the suture separating this sclerite from the lateral ones only faintly marked. Miall & Hammond consider the ventral piece as a portion of the lateral sclerite. The margin of the labium is toothed, the three middle teeth somewhat shorter than those immediately laterad of them [fig.5*l*]. Near the base and ventrad of the mandibles are the maxillae, consisting of fleshy processes, with forward projecting teeth on the lateral margin; a bunch of slender lobes and setae on the inner margin; and a short stout palpus with some terminal spines and papillae [fig.5*mx* and fig.9]. On the ventral surface is a long stout seta. On each side of the labium is a striated and flexible fan-shaped flap which helps to close in the mouth [fig.5]. On the floor of the mouth cavity, lying close to the labium, is the hypopharynx. Its anterior margin is furnished with a number of short spines and bulb and platelike projections. This is the piece which Miall & Hammond, in their work on *The Harlequin Fly*, on page 29, call the upper plate of the labium, or mentum in the figure on page 30. Its function seems to be that of a guide for the silk thread, as is undoubtedly the case with Simulium. The prothoracic pair of feet [fig.4] are furnished with a large number of slender curved hairs, yellowish in color, the two feet

very close together so that they appear as one. The first three segments in specimens which are ready to transform are enlarged and represent the thorax; the intermediate segments are subequal in length and apparently without trace of setae. On the ventral surface of the 11th are two pairs of long blood gills [fig.7], on the caudal end of the dorsal aspect of the last segment are two tufts of five or six long hairs; ventrad of which is a bunch of four very short processes. The anal feet are about as long as the 11th segment, each one with a crown of 12 to 15 bifid claws, resembling the one shown on plate 50, figure 9, but sharper, straighter and more slender, and the inner one comparatively shorter, the angle between the two teeth being about 60°.

The pupa [fig.12] is elongate, its abdomen eight segmented, not counting the anal appendage. The usual respiratory filaments of Chironomus, consist of a pair of much branched tufts. On the lateral margins of each of the segments are a few delicate, transparent filaments [fig.10]; of these there are five pairs on the eighth segment, besides a pair of chitinized toothed claws. On the margin of the anal segment is a close row of hairs, the basal portions of which are stout, but extremely fine at the extremity, where they become matted, forming a paddle [fig.10, 12].

Of course no adults were found in the material, but from some nearly mature pupae the flies were withdrawn, and these possess the following characters. Length, 7 to 8 mm. Dorsum of thorax brown, with the usual three dark dorsal stripes; pectus darker brown; dorsum of abdomen paler brown, the incisures whitish; the ventral surface of each segment with a large, rectangular brown spot, the rest whitish; legs yellowish brown; the tips of all joints blackish. Metatarsus longer than the preceding joint; all tarsal claws simple. Male genitalia complex, consisting of two pairs of blunt lobes, the outer pair the longer; a pair of two jointed claws; and on the dorsal aspect is a single large, heavily chitinized, downward curved hook. Figure 11 shows a side view, the dorsal surface being turned uppermost. The colors given in the above description are doubtless intensified in the living fly. It is hoped that by means of this description the fly may later be recognized.

THALASSOMYIA Schiner

Plate 50, fig.1-15

Verh. Zool. Bot. Ver. 6:216, 1856

This is the first record of the genus from North America. As far as I am aware, but two species have been described, T. f r a u e n f e l d i Schiner and T. c o n g r e g a t a Tomasovary,

both European species. The genus belongs to the group Chironomus *sens. lat.*; but differs from all the other genera of this group in having the fourth tarsal joint shorter than the fifth [fig.14], resembling in this respect Tanypus, and Diamesa, from which it differs in the wing venation; the R–M cross vein wanting; antennae as in Chironomus.

T. obscura n. sp.

This fly was very common here during the past summer, the larva living on the rocky bottom of the shallow, swiftly flowing streams, where the water is but an inch or two in depth [pl.32], sometimes in company with Simulium; it spins a loose cocoon so open and transparent that the larva is not hidden by it, though it prevents the larva from being washed away.

Male. Front and epistome yellow, palpi fuscous, shorter than the antennae, its first joint about one and one half times as long as broad, the second twice, the third three times and the fourth about four times as long as the first. Antennae fuscous, 14 jointed, the first disklike, the second longer than broad, the third to the 13th about as long as broad, the 14th longer than all the others taken together; all furnished with long brown hairs except the apical one fourth of the 14th. Dorsum of the thorax blackish. Yellow on the humeri and pleura, covered with a white bloom, most conspicuous on the humeri. The dorsum of the thorax has a dirty yellow ground color but the three black longitudinal stripes are so wide that only a little of the ground color shows, excepting on the humeri and the two very narrow faint longitudinal stripes separating the three wide, black ones. The scutellum is chestnut; metathorax black; pectus brown; abdomen dull black, the dorsum of the first two segments greenish; the extreme edge of each segment, paler fuscous; the venter greenish, darker, almost black on the more posterior segments. The green is sharply separated from the dorsal color on a lateral line. In dried specimens this green color becomes dusky. Legs almost black, the coxae and bases of the femora yellowish, tarsal claws simple; wings hyaline, hairless, the anterior veins yellowish, the rest hyaline; venation as in the figure; anterior and posterior margin delicately ciliate; genitalia inconspicuous [fig.13, dorsal view]. Halteres white. Length 3 to 5 mm.

Female. Antennae seven jointed, black, with short hairs. Thorax with the black stripes a little narrower than in the male,

hence the yellow stripes separating them and those on the humeri, more conspicuous. Pectus, scutellum, and a little space in front of the latter, brown; the pectus in dried specimens sometimes nearly black; pleura yellow, metanotum black; abdomen as with the male, but the venter paler, legs black, coxae and base of femora yellow; tarsal claws simple; wings hyaline, anterior margin and tip a little smoky; anterior veins yellow; wing margins delicately ciliate; venation as with the male; halteres white. Length 3 to 5 mm.

Larva. The eggs I did not find. The larva is 8 to 10mm in length when full grown, pale or yellowish green in color, its head dark brown and heavily chitinized. The head is somewhat longer than wide, the dorsal suture well marked, and with a few setae arranged as in figure 4. Two setae are placed immediately in front of the transverse suture, and at the apical end of the labrum are two more [fig.4]. A ventral view of the labrum is given in figure 3; *e* representing the epipharynx to which perhaps belongs also the two lateral pieces with their pointed processes. The anterior margin is furnished with a number of small fleshy lobes. The antennae are small, the basal joints about four times as long as wide, with two terminal pieces, one of which is four jointed, the other simple [fig.1]. The mandibles [fig.2] are about twice as long as broad, heavily chitinized, and with five short, blunt terminal teeth; articulated at the base of each is a long slender piece, with four terminal spines. This is shown folded down in the figure. The maxillae are short protuberances, covered with pointed processes; a very short palpus with terminal papillae, and two stout setae projecting ventrad. The hypopharynx [fig.5] is tonguelike, with two long basal pieces. Its apex and its dorsal surface are covered with pointed papillae; ventrally, there is an open arched rib. At the cephalic end of the ventral sclerite and coalescent with it, is the labium, with 11 blunt marginal teeth, the middle one wide and broadly truncated. On the prothoracic segment are the two prolegs, each with about 30 long, curved spines, and a number of small and very short spines on the ventral surface. At the base is a single slender seta, on each side a little dorsad of the lateral line are two more, and caudad of these and below the lateral line a group of three. The 11th segment is without blood gills; the 12th with two comparatively short legs, each with a crown of eight to 10 bifid claws [fig.9, 12]; dorsad of which are two tufts of five or six bristles each. Between the prolegs and projecting caudad are four short blood gills.

Pupa. The pupa is about 4½mm long, with the colors of the adult. It is much shorter in comparison to its breadth than that of Chironomus (*sens. str.*). The wings extend to little beyond

the posterior margin of the second abdominal segment. Eight segments are present besides the short anal segment. On the dorsum of each segment, toward the caudal margin, is a transverse band of stout, black bristles. Each band is composed of five or six rows. The arrangement of these bristles (the longest of which are about one third as long as an abdominal segment) is shown in figure 11. The anal segment is composed of two lobes with a single apical bristle. After two to four days of pupal life, it transforms into the adult.

Genus DIAMESA Meigen

This genus has long been known to occur in Greenland, but has not, till now, been recorded from the United States. In 1898, Lundbeck described three new species from Greenland, one of which, D. aberrata, he considers the species which Staeger erroneously (?) identified as D. waltlii.

Antennae of the female eight jointed, the basal disklike, the intermediate ones rounded, the last cylindrical. Antennae of the males usually plumose and 14 jointed. Eyes oval; the front wide and flat. The eyes and the wings resemble Tanypus. The cell M is separated from the cell M_{1+2+3} by a cross vein, as in Tanypus. The fourth tarsal joint is shorter than the fifth.

Diamesa Waltlii Meigen

1838 D. waltlii Meigen, Syst. Beschr. 7:13, 1
1846 nivoriundus Fitch (Chironomus), Winter Insects of Eastern New York nec Orthocladius nivoriundus Johnson, (?) Cat. of New Jersey Diptera

This fly occurs, sometimes abundantly, in this State from January to April. Fitch's description is rather indeterminate, but I believe it to belong to the species which is described below. I have compared it with specimens from Europe, with which it agrees in all particulars. According to Lundbeck [*Diptera Groelandica*, 1898], D. Waltlii does not possess cilia on the posterior margin of the wing, he quoting Meigen as authority; the European specimens which I have do have these cilia, as do also the American specimens; and I therefore believe that aberrata Lundbeck is also a synonym.

Male. Black. Head black, including eyes, mouth parts and antennae, the latter densely covered with long, dark brown hair. Its first joint enlarged, disklike, the second twice as long as broad, the following 11 a little shorter than broad, the 14th

longer than all the rest taken together. The palpi are somewhat shorter than the antennae, four jointed (besides a small basal piece), the first joint shorter, the fourth longer than the other two. Dorsum of the thorax black, subshining, with a faint cinereous bloom, covering the surface excepting the three slightly raised longitudinal stripes, which are deep black, and on which are arranged some scattered black setae; scutellum dark brown, with black setae; metanotum and pleura black, the latter with a gray bloom; abdomen black, longer than the wings in fresh specimens, covered with fine brown or black hairs, posterior margins of the segments narrowly cinereous.

Genitalia conspicuous and rather complex [pl.47, fig.8 dorsal, fig.10 ventral, view]. The apical joint of the appendages, triangular in outline with a sharp point; the basal joint with a pointed process attached near its base on the inner side, mesad of which are two smaller pointed projections. The dorsal spur is nearly straight and spikelike. Legs uniformly fuscous, all the fourth tarsal joints shorter than the fifth, tarsal claws simple. Wings broad, and nearly as long as the abdomen in fresh specimens; usually longer than abdomen in dried specimens; cinereous in color, the anterior veins conspicuous, brownish or black; media and cubitus pale, posterior margin very delicately ciliate. Halteres usually pale, in some specimens pale brownish, the knob triangular in outline. Length 3.5 to 5mm.

Female. Cinereous black, front and epistome cinereous, eyes but slightly excavated at base of antennae; palpi and antennae fuscous, the latter with eight joints counting the disklike basal joint, short haired [fig.7]; scutellum hemispherical, dark brown, with black setae; abdomen fuscous with short brown hairs, posterior margin of the segments darker except on the extreme edge, which is pale yellow; genitalia small, brown and leaflike; legs fuscous; claws simple; wings broad, and longer than the abdomen; anterior veins black; media and cubitus pale; venation as in the figure. Length 3.5 to 5 mm. All else as with the male. Described from bred and captured specimens.

Larva [pl.48, fig.9–13]. The larvae were taken in company with the larvae of Thalassomyia fusca among the algae on the surface of rocks over which the water flows rapidly. In its pale green color, its general appearance, and even in many details it greatly resembles Thalassomyia fusca. The dorsal sclerite of the head is shaped like that of the last mentioned species shown on plate 50, figure 4; with two pair of marginal setae, but the hindmost pair are situated farther back than in Thalassomyia fusca. On the lateral sclerite there is one seta near the base of the

mandible just above the lateral line, one pair below this one and a little cephalad; another pair about one fourth of the length of the head caudad of these but lying as far below the lateral line as the first is above. Directly caudad of the first, but midway between the front and hind margin of the head, is another. Close to the dorsal suture, one fourth the length of the head cephalad of the caudal margin, is still another; and finally there is a single one on each side at the base of the labium [fig.10].

The ventral surface of the labrum is shown in figure 9. The hypopharynx resembles that shown in plate 50, figure 5; and the maxilla that shown in figure 6. The epipharynx is as shown on plate 48, figure 9*e*, its free end having four to six filaments, the apical pair being stoutest. This member may be bent forward and the filaments then spread out, fanlike. The "jointed appendages" [fig.9*j*] are well developed; each is apically expanded into a handlike process with seven or eight "fingers." These appendages are attached at a point near the anterior margin of the labrum. The mandibles [fig.12] have each five blunt teeth, a fringe of coarse branched hairs projecting mesad, and two stout setae on the dorsal surface near the base. The labium [fig.10] possesses about 19 blunt teeth, no suture being visible between it and the lateral (or ventral?) sclerite. The antennae are of moderate length [fig.11] and bare, with three terminal, jointed appendages. The thoracic and abdominal feet are as on plate 50, figures 7 and 12; but the abdominal legs appear a little longer in proportion to their diameter. The entire body of the larva is almost devoid of hairs excepting the caudal tuft.

Pupa [fig.13]. The pupa is of a fuscous color with a greenish tinge; its thorax is apparently without either tracheal gills or breathing tube. On the dorsal posterior margins of each of the abdominal segments excepting the first and last there are 10 to 12 short, stout, caudad projecting teeth, the two or three lying nearest the lateral margin being smaller than those more dorsad; and on the ventral posterior margin of the abdominal segments excepting the first, second and last there are six or eight stout teeth projecting cephalad. At the anal end of the last segment are three pairs of short hollow filaments, which may have a respiratory function. The length of pupal life is about two days.

This pupa greatly resembles that of Diamesa coulicoides as figured by Heeger in Sitzb. d. k. Akad. d. Wiss. Wien., 1853, excepting that in the latter there are eight caudal filaments instead of six.

Described from specimens taken in Cascadilla creek, Ithaca N. Y., April 1902.

Part 7

SIALIDIDAE OF NORTH AND SOUTH AMERICA

BY K. C. DAVIS

The study leading to the preparation of this paper was made chiefly while the writer was a graduate student at Cornell University, 1898-1900. The writer is under great obligation to Prof. J. H. Comstock and Mr A. D. MacGillivray, of Cornell, for much aid and encouragement; to Mr Samuel Henshaw, of the Museum of Comparative Zoology, for use of the rich collections made by Dr Hagen and others; to Mr William H. Ashmead for the examination and loan of valuable specimens from the United States National Museum; to Dr Henry Skinner for kindness shown while examining specimens in the Philadelphia Academy of Natural Sciences; and to a number of correspondents and others who have given information in regard to distribution, or lent specimens for examination, or aided in other ways.

The family S i a l i d i d a e is of peculiar interest both on account of the large size and the striking appearance of most of its members and because it includes some of the most generalized members of the order Neuroptera.

As is often the case with more primitive groups, the family is a small one, including only four living genera; but it has a world-wide distribution. Fortunately for our purposes, all of the genera are found in our country, and representatives are common in many sections. The four genera are represented in the two Americas by only 32 species.

Family SIALIDIDAE

The members of this family differ from all other Neuroptera in having the hind wings broad at the base, the anal area being folded like a fan when the insect is at rest. They differ from their nearest allies, the Raphididae, in the form of the prothorax, which is quadrangular, while in the Raphididae it is generally elongated. They also differ from most other Neuroptera in being aquatic in their larval state.

Though the family contains only four living genera, these represent two quite distinct lines of development. So well marked are these that they may be considered as representing two subfamilies, which may be designated as the Sialidinae and

the Corydalinae. The more important of the distinctive characters of the subfamilies are included in the following tables.

TABLE TO SUBFAMILIES

Adults

a Accessory veins of radial sector on the front side of vein R_3 [fig. 23]; ocelli wanting; fourth segment of tarsi prominently bilobed ..... Sialidinae

aa Accessory veins of radial sector on the posterior side of vein R_2 [fig. 24, 25, 26]; ocelli three; fourth segment of tarsi obscurely or not at all lobed.....Corydalinae

Larvae

a Anal prolegs wanting; lateral filaments only seven pairs, and distinctly jointed..... Sialidinae

aa Anal prolegs one pair, provided with claws; lateral filaments eight pairs, slightly or not at all jointed. Corydalinae

Egg masses

a Eggs always in one layer [pl.51]..... Sialidinae

aa Eggs in more than one layer [pl.52].....Corydalinae

Eggs

a Distal portion of micropylar projection cylindric, twice as long as broad, joined to the egg by a short neck [fig.20]..... Sialidinae

aa Distal portion of micropylar projection nearly globular, joined to the egg by a long neck [fig.20].....Corydalinae

Subfamily SIALIDINAE

The adult members of this subfamily are all much smaller than those of the Corydalinae; the ocelli are wanting; the accessory veins of the radial sector in both pairs of wings arise from R_3 and extend forward, giving the insect a very characteristic mode of flight; the fourth segment of the tarsi is prominently two lobed.

The subfamily includes a single genus Sialis.

SIALIS Latreille

Besides the characters of the subfamily given above, the following additional generic characters should be added:

Adult. Body and wings black or ferruginous; prothorax quadrangular, almost equal in width to the head, not so long as the mesothorax and metathorax combined; ocelli wanting; an-

tennae filiform, about equal to the body in length; wing expanse 20 to 40 mm, hind wings somewhat less.

The males are usually a little smaller than the females.

Larva. Suited for aquatic life. 20 to 30 mm long when full grown; tapering from head to the caudal end of abdomen; head and thorax yellow on dorsal side, mesothorax and metathorax bearing some light brown markings; the appendages of the head and the eyes brown; abdominal segments brown on the dorsal side and somewhat on the ventral side; first seven segments of the abdomen each supplied with a pair of five jointed, lateral appendages, evidently tracheal gills, each with two rows of delicate hairs [fig. 20]; within these thin, white walled, gill appendages are seen finely divided trachea; from the last abdominal segment is a single caudal appendage similar to but longer than the lateral ones and not jointed and supplied with *two* large branching trachea and *four* rows of delicate hairs. This structure may indicate, as Miall has suggested, that the caudal appendage may have been formed by the fusion of two lateral appendages. There is a pair of minute spiracles present on each abdominal segment except the last. Each antenna has five segments, but the basal one if often obscure.

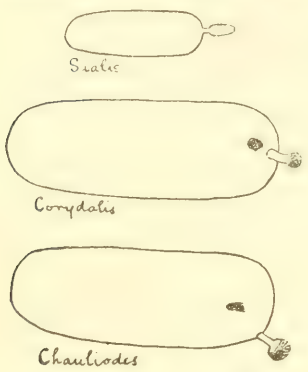

Fig. 20 Eggs of Sialididae

On the dorsal side of the larva of S. i n f u m a t a the segments are translucent, often showing the viscera. The lateral lobes of the abdominal segments are so transparent that the particles of blood may be seen and the pulsations of the heart may be counted. I found the number of pulsations to vary somewhat, but the average is about 10 a minute. Oenocytes with the finest branches of tracheoles leading to them are so plainly visible that they can be photographed.

Eggs. The eggs of S. l u t a r i a , the most common species in Europe, have been briefly described by Miall [1895] as "dark brown, several hundred in one cluster, cylindrical with rounded ends, and closely packed together; from the free end of each egg a small, pointed and whitish projection is given off." The eggs of our most common species, S. i n f u m a t a , have been found in great numbers. They agree with the above description. The "whitish projection," or micropylar projection, is not knobbed at the end, but the distal portion, which may be the micropylar surface, is cylindric in form, with a short, narrow pedicel at the point of attachment to the eggshell.

The masses are often quadrangular but are variable in outline, and are not coated with any protecting material. Several masses are very commonly found near each other; in one case about 150 masses were found within an area 6 by 12 inches; and the remains of the masses of former years are also found near the fresh eggs if the place be a suitable one. The eggs are all placed in a slanting position, i. e. not perpendicular to the surface of attachment; and are all parallel to each other, in one layer, with the micropylar projection outward. Exact counts and estimates show that the number of eggs in a mass is usually from 200 to 500 [pl. 51].

Life history of Sialis infumata

It is an interesting sight to see a female depositing her eggs. This I have witnessed on several occasions. She deposits an entire row of 10 to 20 eggs and then begins another row; as the rows accumulate, she moves backward over the mass to reach the place for the succeeding rows; thus her body and wings cover the egg mass till it is completed. The eggs are always deposited over water or in a place where the young larvae will naturally fall into water. I found them on the under sides of boat landings, on the under and vertical sides of bridges, on stones projecting above the water of creeks and lakes. Stagnant pools are not attractive to members of this genus. The adults do not seem to select the twigs or leaves of trees and shrubs when such objects as those above mentioned are accessible. When a high bridge is selected by the adults, on which to deposit their eggs, they know where the limits of the running water are, and deposit the eggs within those limits.

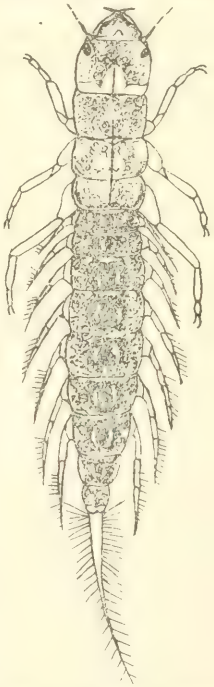

Fig. 21 Larva of Sialis infumata x3 (After Needham)

After seeing females deposit their eggs and after noting the dates when other new eggs were deposited, say on a given rock,

it was an easy matter to determine the length of the egg period. By visiting the region daily till the hatching took place, the period was found to be nine or ten days. Hatching seems to take place only in the dark. In the region of Ithaca in 1899, the hatching took place mostly during the first half of June. It was observed that many masses of eggs never hatch. Some masses of old eggs, apparently dried and dead, were found to hatch when placed in a moist bottle in the collector's pocket. In several cases these were found to hatch within an hour from the time they were taken. The only explanation is that they had become too dry, and the moisture in the bottle helped to soften the eggshells so that the young larvae could break through.

Larva. The young larvae when hatched differ somewhat in appearance and structure from the older larvae above described, specially in having relatively longer filaments and legs, and larger heads with larger mouth parts and only two jointed antennae.

Miall [1895], who has made a study of S. l u t a r i u s, states that the larvae live about a year in streams with muddy bottoms. My observation of S. i n f u m a t a indicates that the larval life is at least two years. However, the exact length is yet to be determined more certainly. Miall states that he found freshly hatched larvae of his species "wriggling out on leaves many yards from the nearest stream or pond." I have seen nothing like this, as S. i n f u m a t a always places the eggs where the young when hatched will fall directly into the water.

The larvae live in the bottoms of streams which are either muddy or sandy. I have most often found them in deep sand or gravel, perhaps 6 inches or a foot below the bed of the stream. At this depth the larvae of Corydalis, perhaps their worst enemies, seldom find them. Tests made as to their food habits show that they are carnivorous, and will eat soft bodied caddis worms, small Chauliodes larvae and even eat one another very readily. The larvae do not come to the surface nor abandon their aquatic life till nearly ready to pupate. When captured, they often eject a black liquid from the mouth. This means of defense is much more commonly used by them than by the larvae of Chauliodes and Corydalis.

Pupa. The pupae of this species have only once been found in their natural conditions by the writer. Prof. J. H. Comstock first found them buried several inches in the earth some yards

from water [fig. 22]. Miall's observations of S. lutaria quite agree with this, and he further states that the adult emerges after two or three weeks.

Fig. 22 Pupa of Sialis infumata x3 (After Needham)

Adults. These have already been described above. They are very awkward fliers and are easily caught even without a net. This quite agrees with the generalized form of the wing venation [fig. 23]. In fact, the adults when approached, will often run rather than attempt to fly. It is probable that the insect lives in the winged form only a few days. All specimens taken were found to die within three days. The dates on which the adults have been collected near Ithaca range from May 13 to June 16, through a series of years. They are diurnal in their habits and seem to prefer bright sunshine. I have found them most abundantly in their egg-laying places at midday, though they also frequent the same places and are active till almost dark.

The short life taken with the fact that the mouth parts of the adult are very poorly developed, would indicate that the adults do not take food. It was reported to Dr Hagen and to the national museum some years ago that the adults of S. nevadensis were very injurious to grapevine leaves. This is the only case of injury yet charged to any members of the family, and may be a false charge. On the other hand, the adults, flying near the surface of water, serve as an abundant supply of food for fishes.

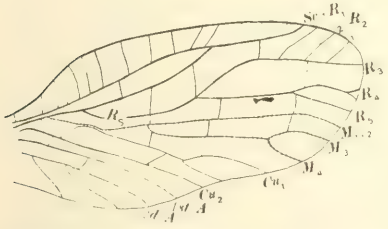

Fig. 23 Fore wing of Sialis infumata x4

KEY TO SPECIES OF SIALIS

a Body and wings black or blackish

b Head black with flat, shining streaks and spots yellowish

c The proximal cross vein between R_1 and R_5 opposite the proximal cross veins between R_5 and M; fore wings rarely with more than two accessory veins arising from R_3; cheeks yellowish ..... 1 infumata

cc The proximal cross veins between R_1 and R_5 distinctly distad of the proximal cross vein between R_5 and M, and which is generally opposite the first fork of media; fore wing never with less than three accessory veins arising from R_3; cheeks black..... 2 fuliginosa

bb Head black in front with a broad orange band behind ..... 3 nevadensis

aa Body either black or ferruginous, wings pale ferruginous, or pale fuscous

b Head black in front, with broad orange band behind; body black..... 4 morrisoni

bb Head yellow, orange, or reddish, with or without dark markings; body never quite black

c Front of head without dark stripes..... 5 americana

cc Front of head marked with black stripes, or suffused with fuscous

d Antennae stout, head with two black stripes; femora yellowish; eyes normal..... 6 bifasciata

dd Antennae slender; head with a long median line, suffused with fuscous in front; femora blackish fuscous; eyes unusually prominent 7 chilensis

DESCRIPTION AND GEOGRAPHIC RANGE OF SPECIES

1 S. infumata Newman

1838 Sialis infumata Newman, Ent. Mag. 5:500
1853 Sialis infumata Walker, Cat. Brit. Mus. Neur. p.195
1861 Sialis infumata Hagen, Synopsis Neur. N. Am. p.188
1863 Sialis infumata Hagen, Ent. Soc. Phila. Proc. 2:181
1863 Sialis infumata Walsh, Ent. Soc. Phila. Proc. 2:261
1892 Sialis infumata Banks, Am. Ent. Soc. Trans. 19:357
1897 Sialis concava Banks, Am. Ent. Soc. Trans. 24:22
1901 Sialis infumata Needham, N. Y. State Mus. Bul. 47, p.542, pl.29

Black; head a little narrower than the prothorax, but not narrowed posteriorly, between the eyes convex to concave, caudal half of head with ferruginous and shining streaks and spots, similar spots between the eyes, more or less conspicuous; antennae black, rather slender; prothorax rounded on the anterior angles, the sides of dorsal aspect with a few impressed points; legs and feet black; wings nearly black, the veins thick and

blacker; R_3 of fore wings with rarely more than two simple or forked branches; the proximal cross veins of R_1-R_5 and R_5-M are opposite. Length to tip of wings 10 to 15 mm; alar expanse 22 to 26 mm. Males are the smaller.

S. concava Banks was said to differ in being always concave between the eyes. This, however, is not a constant character as shown by an examination of hundreds of specimens. Fourteen specimens in the Harvard collection under this label are apparently males of S. infumata.

A species of very wide distribution: arctic America, Quebec, Nova Scotia, throughout New England and New York, New Jersey, Maryland, Washington D. C., Washington N. C., Ohio, Detroit Mich., Galena and Galesburg Ill., Saskatchewan region, in Minnesota at Minneapolis and St Cloud, in California at Lake Tahoe, Placer co., San Geronimo, San Celito.

2 S. fuliginosa Pictet

1836 Sialis fuliginosa Pictet, Ann. Sci. Nat. pl.3, fig.6
1839 Sialis fuliginosa Burmeister, Handb. Ent. 2:947
1856 Sialis fuliginosa Brauer, Verh. Zool. Bot. Ges. p.397
1857 Sialis fuliginosa Brauer & Low, Neur. Aust. p.52
1865 Sialis fuliginosa McLachlan, Ent. Mo. Mag. 2:107, fig.1; and 1866, 3:95
1868 Sialis fuliginosa McLachlan, Ent. Soc. Lond. Trans. 152:8, fig.2

This European species, not formerly reported in America, differs from S. infumata in several points: larger, the alar expanse of the female being 38mm and the three brown spots between the antennae relatively much larger; much more densely pilose throughout, even slightly so on the hind wings; compound eyes ferruginous with several black spots or areas; the proximal cross vein R_1-R_5 is distinctly distad of the proximal cross vein R_5-M, the latter generally opposite the first fork of media. In S. infumata the yellow infusion around the eyes is usually quite distinct, while in S. fuliginosa it is much less so. Fore wings never with less than three accessory veins arising from R_3; these are either simple or forked.

Six specimens collected by Morrison 1878, Reno Nev., one from Morris county, Cal., two from Mendocino Cal., and two

from Webber lake, Cal., agree with this characterization, and are like the European specimens in the Museum of Comparative Zoology.

3 S. nevadensis n. sp.

Body black; head not narrowed behind, black with orange band clear across the caudal half and reaching around under the eyes to the antennae, smooth streaks and spots of the same color in the orange band above, no such spots between the antennae; eyes black; prothorax hardly narrower than the head, black, not at all marked with the orange color, anterior angles obtuse; antennae black, very slender; feet and legs black; legs pilose; wings black, translucent, either shining or dull, veins darker if possible; Sc-R_1 cross veins only one or two; R_3 with two simple or forked branches. Length to tip of wings 18 to 25 mm; alar expanse 38 to 40 mm.

Collected by Morrison at Reno Nev., 1878. In Nevada county, Cal., June 12, 1880, said to be "very injurious to grapevine," or "injuring grape leaves." Types in United States National Museum catalogue no. 5177.

4 S. morrisoni n. sp.

Body black; head and thorax shaped and marked as in S. nevadensis; legs and feet ferruginous; wings ferruginous, veins hardly darker; venation as in that species. Length to tip of wings 20mm; alar expanse 40mm.

Collected by Morrison, Reno Nev., 1878. Type in Museum of Comparative Zoology.

5 S. americana Rambur

1842 Semblis americana Rambur, Hist. Nat. Neur. p.447
1853 Sialis ferrugineus Walker, Cat. Brit. Mus. Neur. p.195
1861 Sialis americana Hagen, Synopsis Neur. N. Am. p.188
1892 Sialis americana Banks, Am. Ent. Soc. Trans. 19:357

General color ferruginous; head narrower behind; eyes black; caudal half of head with flat streaks and spots shining and surrounded with ferruginous; antennae ferruginous; anterior angles of prothorax square; prothorax a little narrower than the head, sides with yellowish impressed punctures; femora ferruginous; feet fuscous; wings pale ferruginous, the veins

darker; R_3 only one branched; Sc-R_1 cross vein only one. Length to tip of wings 12 to 14 mm; alar expanse 24 to 26 mm.

Reported from Georgia and Pennsylvania. One specimen in the Museum of Comparative Zoology. Hagen [1861] is my authority for placing the name given by Walker as synonymous with the above.

6 S. bifasciata Hagen

1861 Sialis bifasciata Hagen, Synopsis Neur. N. Am. p.188

General color ferruginous; head not narrowed posteriorly, color orange with two broad, black stripes, shining orange streaks and spots behind; antennae stout, black, pilose; prothorax orange, anterior angles obtuse, sides with broad fuscous somewhat shining stripe and flat points; femora yellowish with base fuscous; feet fuscous; wings pale fuscous, somewhat shining, front ones obscure on costal margin, veins pale fuscous. Length to tip of wings 10 to 12 mm; alar expanse 17 to 20 mm.

Cuba.

7 S. chilensis McLachlan

1870 Sialis chilensis McLachlan. Ent. Mo. Mag. 7:145

Fusco-nigra, abdomen black; head reddish, an impressed median longitudinal line reaching the hind margin, joining a sinuate line in front before the antennae, frontal part and at sides of median line suffused fuscous, a fuscous spot on each side below the eyes; labrum truncate in front, testaceous; eyes larger and much more prominent than in other species; thorax blackish fuscous, very narrow, clothed with a short pubescence; antennae and palpi black; legs and feet blackish fuscous, short pubescent; claws and beneath lobes of fourth tarsal joints testaceous; wings smoky, somewhat shining, membrane with short, black hairs, pale space in each wing below the juncture of R with Sc; veins black, costal area narrow, slightly dilated, with about seven C-Sc cross veins, R_3 with but one forked branch; front wings long and narrow, apex long elliptic; hind pair slightly broader.

Chile.

S. lutaria Linn. is the most common European member of the genus. There are seven specimens in the Hagen col-

lection. The alar expanse of the males is 25 mm and of the females 35 mm. The antennae are nearly equal to the expanded fore wings but are variable. The compound eyes are marked about as in S. fuliginosa. The species is much like S. infumata in most particulars, but there are only one or two Sc-R_1 cross veins of the fore wings; R_2 has two simple or forked branches going forward, and there is no yellow infusion spreading around the eyes; the legs are ferruginous, not black. Larvae in alcohol have abdomen black with a row of yellow markings down the middle of the dorsal side. The pupa has no abdominal appendages, and is very light yellow all over, and has a whorl of hairs over each abdominal segment.

S. sibirica McLachlan. Four specimens with this label are in the Hagen collection, but they do not differ from the specimens of S. lutaria.

Subfamily CORYDALINAE

Here we find the accessory veins of the radial sector in both pairs of wings arising from R_2 and extending backward. The insects are provided with three ocelli. The tarsi are not at all lobed or sometimes slightly so. Anal prolegs and claws are present in the larvae. Three genera are included in this subfamily, Chauliodes, Neuromus, and Corydalis.

TABLES TO GENERA

Adults

a Mandibles when closed largely concealed by the labrum; mandibles of male hardly more elongated than those of the female; white dots rarely found within the cells of the wings

b Media of the fore wings with only two branches [fig.24]; lateral margins of the head not toothed [pl.52]....Chauliodes

bb Media of the fore wings always with more than two branches [fig.25]; lateral margin of the head bidentate or unidentate or only slightly unidentate in N. corripens.....Neuromus

aa Mandibles when closed not concealed by the labrum; mandibles of male enormously elongated; white dots always found in some of the cells of the fore wings.....Corydalis

Larvae

a Tracheal gills wanting; last pair of spiracles raised on prominent conical folds or long respiratory tubes.....Chauliodes

aa Tracheal gills on ventral side of the first seven abdominal segments; last pair of spiracles not raised on respiratory tubes nor on conical folds
b Antennae with five segments.....Neuromus
bb Antennae with six segments.....Corydalis

Egg masses[1]

a Mass not covered.....Chauliodes
aa Mass normally covered with a whitish coat of albuminous matter.....Corydalis

Eggs

a Micropylar projection distinctly at one side of apex; neck less than half the width of micropylar surface [fig.20]...Chauliodes
aa Micropylar projection near the apex; neck nearly as broad as micropylar surface [fig.20].....Corydalis

CHAULIODES Latreille

Adult. Smaller than Corydalis; body 20 to 40 mm long, the male often being smaller than the female. Prothorax quadran-

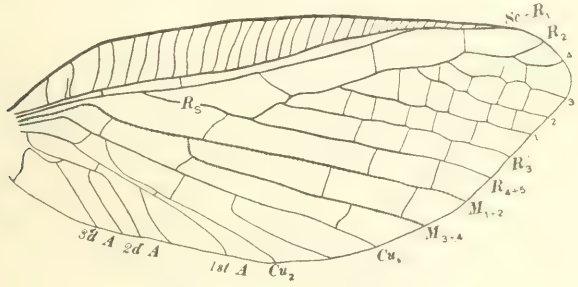

Fig. 24 Fore wing of Chauliodes x3

gular, narrower than the head, and shorter than the mesothorax and metathorax combined; no toothed angle on sides of the head; three large approximate ocelli facing at about 120° from each other; antennae moniliform serrate, pectinate, or flabellate; mandibles not prominent, concealed by the labrum when closed; wings numerously veined, the accessory veins of the radial sector extend backward from R_5 in both pairs of wings; radial sector with four to six branches, and medius always with only two branches [fig. 24]; cross veins between all the branches of radius varying in different species, from seven to about 20; hind wings broad at base and folded in the anal area when at rest; alar expanse 50 to 90 mm; tarsi cylindric, five jointed; caudal appendages conical, stout, inferior pair often simple in both sexes, superior pair simple in female and slightly prehensile in male.

[1]Eggs of Neuromus have never been described.

Larva. Aquatic; about half as large as the larva of Corydalis when full grown; dark fuscous with black or dark head and prothorax; clavate projections on the skin present, similar to those found on larva of Corydalis, but of a light brown color and much less distinct. Last four or five segments of the abdomen tapering toward the caudal end of the body; first eight segments of the abdomen each with a pair of whitish lateral filaments 6 to 8 mm long, which may serve as tracheal gills in the younger larvae; these are sometimes indistinctly five jointed and are sometimes only slightly clothed with hairs; no ventral tufts of tracheal gills present; spiracles are found on a fold between the prothorax and the mesothorax and on each of the first eight abdominal segments, the last pair being raised more or less on prominent conical folds or terminating a pair of slender tubes. These tubes, in the species where they are present, are very contractile and vary in length at times from about 5 to 12 mm [*see* Lintner, 1893, pl.1]. On the last segment is a pair of anal prolegs, each with a pair of claws and a lateral filament which is decidedly hairy; antennae with five segments, the first segment often being retracted.

Several larvae in the Museum of Comparative Zoology are much like the ones I have formerly collected. Eight collected at Cambridge have no central black stripe on dorsal aspect of abdomen and thorax. One sent by H. Edwards from California has last pair of spiracles nearly sessile. The lateral filaments are unusually long and rather distinctly jointed. Specimens collected in Kentucky by Sanborn have last pair of spiracles nearly sessile, and the last pair of lateral filaments very long, reaching much past the anal ones. The last pair of respiratory tubes are clearly shown, and are confluent or adjacent at their base on specimens collected at Brookline by Mr Henshaw.

Eggs. The eggs of Chauliodes have been described and photographed by Dr Needham [1901]. Riley [1879] briefly compared them with eggs of Corydalis in these words: "Eggs of Chauliodes have a larger tubercle or stem on the top, and are not covered with white, albuminous material as are those of Corydalis." These are the only references to the eggs which I have found in literature.

The masses are shaped not unlike the masses of Corydalis eggs, but are more variable in size and shape. They are reddish brown, with no protective coating over the mass. The eggs of a mass are usually placed in three layers of unequal size, the smallest layer being on top; the longer axis of each egg is parallel to the surface to which the mass is attached [pl. 52, fig. 2].

The brown or pink micropylar projection is knobbed, and is placed a little to one side of one end of the egg: otherwise the egg is cylindric, with rounded ends [fig. 20].

Life history of Chauliodes

The eggs were first found by the writer on the underside of a boat landing built of wood, on the southeast shore of Cayuga lake near Ithaca N. Y., June 14, 1899, while searching for them. In this case there was but a single mass, freshly deposited within two feet of the surface of the water. The second lot, found June 16th in Coy glen, was composed of three groups or clusters, each cluster being made up of about 30 or 40 egg masses. Each mass has from 1000 to 2000 eggs. These were all within a radius of 2 feet on a large glacial rock, about 2 or 3 feet above running water. Farther up the glen in many places I found single masses on small rocks overhanging the water. Some of these were 10 or 15 feet above the water. In one case a mass was found on an overhanging limb of a tree. Mr A. D. MacGillivray has frequently found them on leaves and limbs. Stones seem to be preferred by the adults when depositing their eggs.

The hatching takes place at night, five or six days after the eggs are deposited. The young larva breaks from the egg at the end near the micropylar projection, which is the cephalic end of the embryo, and readily finds its way to the water, usually by dropping directly from the egg mass or the object to which it is attached.

The freshly hatched insect differs from the more mature larva in having the lateral filaments relatively much longer, and the head larger; and the antennae only two segmented.

The young are not very active and will remain in the portion of the stream below the egg mass for several months or probably longer if not carried away by the strong current. A muddy bottom is not distasteful to them, though they may be found in many parts of our common streams; they are less frequently found in the swiftest parts. The species (C. s e r r i c o r n i s)

with the long caudal breathing tubes have been found only in stagnant or quiet water.

The larvae are carnivorous, and do their feeding chiefly in the dark. The large larvae readily eat smaller ones of their own species, and larvae of Sialis, caddis worms, small dipterous larvae, and other accessible forms with soft bodies. Weed [1889] says that a larva in an aquarium ate Notonecta undulata, house flies, and a spider.

The length of the larval period has not been definitely determined. It may be judged from the data already known that it is about three years. The amount of increase at each molt, if found from a number of examples, would furnish data for determining the number of molts. The number of molts compared with the average time between molts would determine rather closely the larval period. The great difficulty in the way of determining the number and average time of the molts, is that they can not easily be cared for and fed in their exact natural conditions through a long period and their increase at each molt carefully measured. Larvae if fed well will doubtless molt more rapidly than those which are poorly fed. I kept larvae alive in running water from Sep. 2, 1899, to June 1, 1900. Only two of them molted during that period, but they were very poorly fed.

Young larvae which hatched June 15 to 20, 1899, over a quiet part of a brook where the bottom was a large, flat rock deeply covered with sediment, were found in great numbers and of nearly uniform size four months later, at the close of the warm season. It is from these and from the range of sizes observed at one place as the result of one day's collecting, that I have thought the larval period must be about three years.

When fully fed and of proper age, the larva leaves the water, makes a cell in rotten wood, in the earth, or under a stone or even in mud, where it sheds the last larval skin to assume the pupal form.

The pupae are difficult to find, as they are often far from water and may be buried several inches in the ground. The

length of the pupal stage has not yet been exactly determined, but the period is probably not longer than two weeks. Walsh and Weed both mention C. rastricornis, as being found under bark of the upper side of logs floating in water. They were doubtless there to pupate. Weed speaks of the pupa stage of that species as lasting eight days in one case and 14 days in another case. H. L. Moody [1878] notes that a specimen of C. pectinicornis spent 12 days in the pupa stage.

The pupae are quiescent but can crawl when disturbed. The color is at first light brown but becomes dark before the emergence of the adult insect. As in the case of Sialis and Corydalis, the pupae very much resemble the adults in many points of external structure. Walsh says of pupae of C. rastricornis, that at least the female has two robust obtuse abdominal appendages, about 2mm long, confluent at base; and an inferior process of two similar ones, connate throughout.

The adults are better fliers than Sialis, but are still very awkward and are not difficult to catch. They are chiefly crepuscular, but often fly in the late morning, and are easily frightened from their diurnal hiding places along a wooded stream. Specimens taken to cages have all died in a very short time, and it is probable that the life in the winged state is only a few days. They have not been known to take food in this state.

Adults of C. serricornis have been collected at Ithaca from June 9 to 18 in various years.

KEY TO SPECIES OF CHAULIODES

a Wings black or brown with white markings
b A continuous, broad, somewhat arcuate white band extending across the middle of each wing almost attaining the hind margin of each; antennae serrate in the female, flabellate in the male ..... 1 fasciatus
bb An irregular band of white spots, generally broadest in front, extending across the middle of each front wing, on the hind wing represented by only a few minute dots which may be wanting; antennae more or less serrate in both sexes [pl.52] ..... 2 serricornis

aa Wings somewhat ashy in color with more or less dusky markings
b Veins of fore wings marked with dark and light uniformly alternate
c Antennae of both sexes serrate; prothorax with pale line in middle behind.....3 rastricornis
cc Antennae of both sexes pectinated.....4 pectinicornis
bb Veins of fore wings uniform in color except where the dusky markings cross them
c Head yellow behind by the confluence of the smooth areas
d Antennae brown.....5 angusticollis
dd Antennae blackish..... 6 concolor
cc Head with the smooth areas dark brown or blackish
d Antennae black; alar expanse 50 to 65 mm.. 7 minimus
dd Antennae brown; alar expanse 75 to 100 mm
e Area about ocelli much depressed; antennae of male about equal in length to head and thorax; those of female much shorter ..... 8 disjunctus
ee Area about ocelli not depressed; antennae of male densely bristly, as long as body..9 californicus

DESCRIPTION AND GEOGRAPHIC RANGE OF SPECIES

1 C. fasciatus Walker

1853 Chauliodes fasciatus Walker, Cat. Brit. Mus. Neur. p.201
1861 Chauliodes serricornis Hagen, Synopsis Neur. N. Am. p.190
1863 Chauliodes lunatus Hagen, Ent. Soc. Phila. Proc. 2:180
1863 Chauliodes lunatus Walsh, Ent. Soc. Phila. Proc. 2:262
1869 Chauliodes fasciatus McLachlan, Ann. and Mag. Nat. Hist. (4), 4:40
1892 Chauliodes lunatus Banks, Am. Ent. Soc. Trans. 19:357

General color dark brown or black; head rufous, the disk fuscous, head of male more slender and more highly colored, back of head with flat, rufous streaks; prothorax with impressed rufous spot each side, that of the male more slender and more highly colored; legs luteofuscous, tarsi duller in color; antennae black, serrate in female, flabellate in male, each joint with a large oval plate underneath; wings brownish black, fore pair

with a broad white band, pointed with fuscous, not attaining the posterior margin; one or more apical marginal spots, some cross veins bordered with white; posterior pair with a broad arcuate white band not attaining the posterior margin, and a large rounded basal white spot, also a small apical spot and sometimes the cross veins bordered with white. Length to tip of wings 35 to 40 mm; alar expanse 60 to 70 mm. The males are the more highly colored on the head and thorax, and the dark part of their wings is more uniformly black.

The inferior appendage of the male is elongated, narrower at tip, and of a pale brown color. The males are the smaller.

When the wings of this species are spread, the white are across their center is nearly continuous from one to the other.

New York, Pennsylvania, Glen Echo D. C., Maryland, Sugar Grove O., Illinois, Lake of the Woods, Missouri, Arkansas, Mexico.

2 C. serricornis Say

1824 Chauliodes serricornis Say, Long's Exp. 2:307
1839 Chauliodes serricornis Burmeister, Handb. Ent. 2:949
1842 Neuromus maculatus Rambur, Hist. Nat. Neur. p.442, pl.10, fig.2
1853 Hermes maculatus Walker, Cat. Brit. Mus. Neur. p.202
1859 Chauliodes serricornis Say, Am. Ent. LeConte ed. 1:206
1861 Chauliodes maculatus Hagen, Synopsis Neur. N. Am. p.191
1863 Chauliodes serricornis Hagen, Ent. Soc. Phila. Proc. 2:180
1863 Chauliodes serricornis Walsh, Ent. Soc. Phila. Proc. 2:262
1869 Chauliodes serricornis McLachlan, Ann. and Mag. Nat. Hist. (4) 4:40
1892 Chauliodes serricornis Banks, Am. Ent. Soc. Trans. 19:357
1892 Chauliodes serricornis Say, Banks, Am. Ent. Soc. Trans. 19:357
1901 Chauliodes serricornis Needham, N. Y. State Mus. Bul. 47, p.549, pl.27

Body black; back of head with flat, ferruginous streaks and spots which are sometimes black; prothorax fuscous, impressed each side; legs and feet nigro-fuscous; antennae serrate in both sexes; inferior appendage of male is of a shining black at tip; wings black, a transverse interrupted white line in middle of front wings, widest at anterior margin, not attaining the pos-

terior margin; hind wings in middle with a few minute white dots which may be wanting; some white apical spots in both wings, these often united in hind wing to form larger white apical areas. Length to tip of wings 30 to 38 mm; alar expanse 45 to 55 mm [pl.52, fig.1].

Massachusetts, New York, Pennsylvania, Washington D. C., Maryland, Georgia; in Ohio along tributaries of the Muskingum in Knox county; in Minnesota at St Cloud, St Johns and Minneapolis.

3 C. rastricornis Rambur

1842 Chauliodes rastricornis Rambur, Hist. Nat. Neur. p.444
1853 Chauliodes rastricornis Walker, Cat. Brit. Mus. Neur. p.198
1853 Hermes indecisus Walker, Cat. Brit. Mus. Neur. p.204
1861 Hermes pectinicornis Linnaeus, Hagen, Synopsis Neur. N. Am. p.189
1861 Chauliodes rastricornis Hagen, Synopsis Neur. N. Am. p.189
1863 Chauliodes rastricornis Hagen, Ent. Soc. Phila. Proc. 2:181
1863 Chauliodes rastricornis Walsh, Ent. Soc. Phila. Proc. 2:263
1869 Chauliodes rastricornis McLachlan, Ann. and Mag. Nat. Hist. (4), 4:40
1892 Chauliodes rastricornis Banks, Am. Ent. Soc. Trans. 19:357
1901 Chauliodes rastricornis Needham, N. Y. State Mus Bul. 47, p.546

General color luteo-cinereous; head behind with flat, black streaks and spots; prothorax with a slight impression on the middle behind, a flexuous impressed stripe each side; legs luteous, tarsi fuscous; antennae of both sexes serrate; front wings subcinereous, obscurely clouded with fuscous, veins marked with dark and light uniformly alternate; hind wings cinereous. Length to tip of wings 45 to 55 mm; length of body 5 to 50 mm; alar expanse 65 to 80 mm.

New York, Pennsylvania, South Carolina, Georgia, western Florida, Sullivan Ind., Illinois, Missouri.

4 C. pectinicornis Linnaeus

1763 Hemerobius pectinicornis Linnaeus, Amoen. Acad. 6:412 and Centures Insector, p.29, 87
1767 Hemerobius pectinicornis Linnaeus, Syst. Nat. ed. 12. p.911
1773 Hemerobius pectinicornis DeGeer, Mem. Ins. 3:562, t. 27, fig.3
1773 Hemerobius virginiensis Drury, Ill. Nat. Hist. v.2, Apx.
1775 Hemerobius pectinicornis Fabricius, Syst. Ent. p.309
1781 Semblis pectinicornis Fabricius, Sp. Ins. 1:386; and 1787. Mantissa Ins. 1:244; and 1793. Entom. Syst. 2:72.
1805-21 Hemerobius pectinicornis Palisot, Ins. Afr. and Am. Neur. t. 1, fig.2
1807 Chauliodes pectinicornis Latreille, Gen. Crust. and Ins. 3:198
1836-49 Chauliodes pectinicornis Cuvier, Règne Animal, p.14; t. 105, fig.2
1837 Hemerobius pectinicornis Drury, Ins. Westw. ed. 1:105, t. 46, fig.3
1839 Chauliodes pectinicornis Burmeister, Handb. Ent. 2:950
1842 Chauliodes pectinicornis Rambur, Hist. Nat. Neur. p.441
1853 Chauliodes pectinicornis Walker, Cat. Brit. Mus. Neur. p.198
1861 Chauliodes pectinicornis Hagen, Synopsis Neur. N. Am. p.189
1861 Chauliodes virginensis Hagen, Synopsis Neur. N. Am. p.190
1869 Chauliodes pectinicornis McLachlan, Ann. and Mag. Nat. Hist. (4), 4:40
1869 Chauliodes virginiensis McLachlan, Ann. and Mag. Nat. Hist. (4), 4:40
1892 Chauliodes pectinicornis Banks, Am. Ent. Soc. Trans. 19:357
1892 Chauliodes virginiensis Banks, Am. Ent. Soc. Trans. 19:357
1901 Chauliodes pectinicornis Needham, N. Y. State Mus. Bul. 47, p.547; also pl.26, fig.1 (erroneously named)

General color lutec-cinereous; hind part of head with yellowish, flat streaks and spots; prothorax with a middle stripe behind yellowish, and a yellow flexuous stripe each side; legs yellowish, tarsi fuscous; antennae fuscous, pectinated; front wings grayish, often obscurely clouded, transversely streaked with fuscous; veins fuscous, uniformly interrupted with white; radial sector with six or seven branches; hind wings grayish; cross veins between all the branches of radius in front wings,

about 20 to 22. Length to tip of wings 45 to 60 mm; alar expanse 58 to 90 mm. The female is the larger.

New England, New York, Ohio, Detroit Mich., Wisconsin, central Missouri, Maryland, Virginia, South Carolina, Florida, Louisiana.

5 C. angusticollis Hagen

1861 Chauliodes angusticollis Hagen, Synopsis Neur. N. Am. p.191
1869 Chauliodes angusticollis McLachlan, Ann. and Mag. Nat. Hist. (4), 4:40
1892 Chauliodes angusticollis Banks, Am. Ent. Soc. Trans. 19:357

General color fusco-testaceous; mandibles yellow; head small, yellow behind by the smooth spots and streaks blending together, black across between the eyes; ocelli yellowish white; prothorax narrow, a fulvous stripe in the middle posteriorly and a lateral one each side; legs fuscous; antennae of female nearly filiform, brown; those of male nearly moniliform, clothed with brown bristles, the two basal joints nearly smooth; appendages of male stout, obtuse, oblique; wings gray much marked with brownish black points and patches scattered over the front wings and costal and distal areas of the hind ones; cross veins between all the branches of radius in front wings, about nine to 11; radial sector of same pair with four to five branches. Length to tip of wings 35 to 42 mm; alar expanse 55 to 70 mm.

Georgia, Virginia, Kentucky, Illinois.

6 C. concolor n. sp.

Body dusky; head light yellow behind by the fusing of the smooth shining stripes and areas; prothorax longer than wide, narrower than the head; a brown median line behind, and irregular brown marks each side; ocelli light colored; antennae nearly black, rather long, nearly moniliform, clothed with short bristles beyond the basal joint; legs brown, feet dusky; wings cinereous with numerous small dusky markings, specially on front pair and costal area of hind pair; veins mostly dark and each of nearly uniform color throughout; a transverse dusky line near base of front wings; in the front pair, cross veins

between all the branches of radius, about seven to 10, and radial sector with five branches. Length to tip of wings 45 to 55 mm; alar expanse 70 to 85 mm.

Ithaca N. Y. The dates on all specimens in Cornell collection, so far as they are dated, are in the latter half of July.

The species is most like C. californicus in general appearance, but differs in color of the hind part of the head, color of the antennae and feet, and in other minor points.

7 C. minimus n. sp.

Body color blackish; mandibles black; head small, black, with smooth raised streaks and spots behind black; prothorax black, very narrow, smooth raised places almost wanting; legs and feet black; antennae very slender, filiform to moniliform, black, nearly equaling the body in length; wings much like those of C. californicus in color and markings; the front pair with cross veins between all branches of radius, about seven, and radial sector divided into five branches. Length to tip of wings about 28 to 35 mm; alar expanse 50 to 65 mm.

San Rafael Cal. Types in Museum of Comparative Zoology.

8 C. disjunctus Walker

1866 Chauliodes disjunctus Walker, Lord's Naturalist in Vancouver isl. 2:334

1869 Chauliodes disjunctus McLachlan, Ann. and Mag. Nat. Hist. (4), 4:40

General color brown, often with cinereous hairs; mandibles with black tips; head dark rufous, thickly punctured, hind part with long, shining, dark streaks, some of which are not continuous; prothorax rather long and much narrower than the mesothorax; legs lightest toward the body, varying in color from blackish to yellowish brown; antennae very short, brown, pilose; wings cinereous, with numerous dark brown spots and dots, some of which form incomplete transverse lines most marked on front wings; that pair with some of the spots collected into about five costal patches, some very dense basal spots; radial sector of front wings with five to six branches; cross veins between all the branches of radius, about seven to nine. Length

to tip of wings 75 to 90 mm; alar expanse 90 to 125 mm. This species includes the largest members of the genus found in the new world.

Vancouver island; in California at San José, and near Alder Creek, Sacramento co.

9 C. californicus Walker

1853 Chauliodes californicus Walker, Cat. Brit. Mus. Neur. p.199
1861 Chauliodes californicus Hagen, Synopsis Neur. N. Am. p.190
1869 Chauliodes californicus McLachlan, Ann. and Mag. Nat. Hist. (4), 4:40
1892 Chauliodes californicus Banks, Am. Ent. Soc. Trans. 19:357

Body brownish black; mouth parts rufous, mandibles often with only one tooth below the apex; hind part of head rufous with flat, somewhat shining streaks and spots; prothorax behind with a flexuous, obsolete, rufous stripe, the middle elevated and more obsolete; legs brown; antennae brown, stout, long as body in male, much longer than head and thorax in female; those of the male densely covered with bristles, giving a feathered appearance; two basal joints naked; wings cinereous, veins of front pair transversely lined with the fuscous markings of the cells which cross them; from costal margin of all the wings a basal brownish black streak, and sometimes apical ones; other brown spots often present, specially on the front wings; in front pair, cross veins between all the branches of radius, about seven to nine; and radial sector with five branches. Length to tip of wings 45 to 60 mm; alar expanse 75 to 100 mm.

Mariposa and in Siskiyou county, Cal. and Reno Nev.

10 C. cinerasceous Blanchard

1851 Chauliodes cinerasceous Blanchard, Gay, Hist. Chile, v.6, Neur. pl.2, fig.10
1861 Chauliodes chilensis Hagen, Synopsis Neur. N. Am. p.321 (*nomen nudum*)
1869 Chauliodes cinerasceous Blanchard, McLachlan, Ann. and Mag. Nat. Hist. (4), 4:41

General color ashy; head pale variegated; prothorax rugose, a pale line behind; legs and feet same color as abdomen, wings

cinereous, front pair dusky spotted all over, spots minute and more obscure at costal margin, some spots larger; hind pair slightly spotted. Length of body 20mm. (The figure measures 26mm); length to tip of wings about 55mm; alar expanse 75 to 80mm.

In Chile at Valparaiso and Valdivia. Blanchard said, *Esta especie parece rara en Chile.*

I have seen no specimens of this species, and therefore I quote Blanchard's description:

Ch. omnino cinerasceus; capite pallido-variegato; prothorace rugoso, linea postica pallida; alis cinereis, anticis undique fusco-maculatis, maculis minutis margine costali obscurioribus, non-

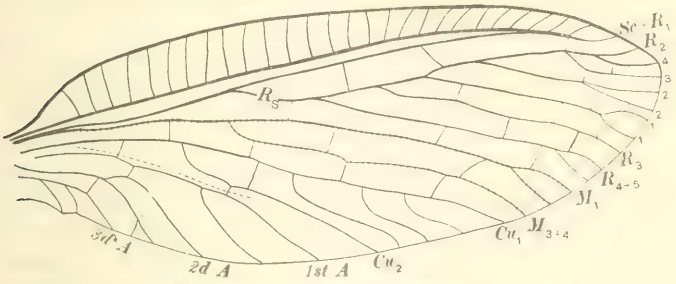

Fig. 25 Fore wing of Neuromus pallidus x2

nullis majoribus; alis posticis leviter maculatis; pedibus abdomineque concoloribus. Longit., corpor. 10 lin; enverg. alar., 30 lin.

Hagen afterward said his species equals C. cinerasceous Blanchard.

NEUROMUS Rambur

Adult. Color from nearly black to light yellow; usually somewhat smaller than Corydalis adults; mandibles of male never elongated nor annular as in Corydalis. Cheek once or twice toothed or with a sharp angle. Prothorax quadrangular to cylindric, narrower than the head, longer than broad and shorter than the mesothorax and the metathorax combined. Three large approximate ocelli facing outward. Antennae always filiform or nearly so, and usually not longer than the head and thorax combined. Medius with more than two branches [fig.25]; cross veins between branches of radius, from 10 to 30, but the number is rather constant in each species; Cu_1 with one or two accessories in some species, to four or five in others.

Larva. No published account of Neuromus larvae has appeared. They are doubtless very rare in the United States, and

when found have probably been mistaken for larvae of Corydalis.

There are two lots, or 14 unnamed specimens, from the Himalaya region, in the Museum of Comparative Zoology, sent from Kullu, by M. M. Carleton, a missionary, some years ago. (One lot dated 1872). These I consider are larvae of Neuromus, as they differ materially from the Corydalis larvae so familiar to us, and as adult specimens of Neuromus were sent by the same collector from the same region, and Corydalis has never been reported from that part of Asia.

They are distinguished from Corydalis (1) by the *black* ring about the spiracles; (2) by the antennae being only five jointed as in Chauliodes larvae; (3) by the abdominal gill tufts being more distinctly peduncled.

They have eight pairs of abdominal spiracles, one well developed pair and one rudimentary pair on the thorax; seven pairs of tracheal gill tufts. The body above is very black with the clavate projections. These are found distributed over the more flexible parts of the body and filaments. Lateral filaments eight pairs, with a row of tufted hairs on dorsal side of six front pairs, more tufts on the others. The head and thorax are dark without distinct markings. Prothorax longer than wide and as wide as the head; eyes each with six ocelli; labial palpi with three joints above the base.

The larvae appear much like those of Chauliodes, but the presence of the tracheal gill tufts excludes them from that genus, while the black ring and center of each spiracle, as well as the five jointed antennae, separate them quickly from Corydalis.

Eggs. The eggs of this genus have never yet been recognized, but we would expect them to be most like those of Corydalis.

TABLE TO SPECIES OF NEUROMUS

a Sides of head with alate bidentate process...	1 soror
aa Sides of head only once toothed or only slightly angled	
b Front wings with white dots in most of the cells back of the costal region.....	2 cephalotes
bb Front wings not marked as above	
c Head black, wings brown in distal half...	3 maculipinnis
cc Head and body yellowish; wings mostly yellowish; dark markings on the prothorax	
d Front wings spotted with black or brown posteriorly, and with their cross veins mostly dark; metathorax often marked with black or brown..	4 hieroglyphicus

dd Front wings not spotted with dark; cross veins dark or not; metathorax not marked with black or brown
e Cross veins of fore wings more or less darkened (brown or black)
f Dark markings on prothorax distinct; media of fore wings with six branches; cross veins between all branches of radius, 25 to 30.. 5 corripiens
ff Dark markings on prothorax indistinct; media of fore wings with 3 (?) branches; cross veins between all branches of radius, 10 to 12..... 6 winthemi
ee Cross veins of fore wings not darkened 7 pallidus

DESCRIPTION AND GEOGRAPHIC RANGE OF SPECIES

1 N. soror Hagen

1861 Corydalis soror Hagen, Synopsis Neur. N. Am. p.193

General color luteous; mandibles brown; cheeks with alate bidentate process; head broad, not depressed, a brownish stripe each side; prothorax narrower than head, longer than broad, each side with a brownish border; legs lurid with knees and apex of tarsi obscurer; antennae short, slender, black, the two basal segments yellowish; appendages of male four, superior ones forcipated, clavate at apex; inferior ones cylindric, extremely short; wings luteo-subhyaline, an obsolete band on the middle of front pair, and fuscous spots nearer the apex; veins fuscous, luteous on the middle of the costal space; cross veins between all branches of radius, about 18 to 21; medius of fore wing four branched; Cu_1 with four to five accessories. Length to tip of wings 60 to 75mm; alar expanse 85 to 130mm.

Mexico, Cordova.

2 N. cephalotes Rambur

1842 Corydalis cephalotes Rambur, Hist. Nat. Neur. p.441
1853 Corydalis cephalotes Walker, Cat. Brit. Mus. Neur. p.208
1861 Corydalis affinis Hagen, Synopsis Neur. N. Am. p.321 *(nomen nudum)*
1866 Corydalis hecate McLachlan, Jour. of Ent. 2:499, pl.20

Color of body dark brown, mandibles and mouth parts reddish brown; head dark brown, roughened behind but not marked

with lighter color; cheek with sharp tooth; prothorax longer than broad, blackish brown, hastate groove same color; femora dusky, tibiae and tarsi yellowish; antennae slender, filiform, brownish yellow, blackish at tips, about equal to head and thorax in length; appendages of male four, superior pair thin, nearly flat, not angled at the end, shorter than the inferior ones; wings dull brown with white dots in cells, and mostly black on costal region of front pair, and white areas in stigma and back of medius in middle of wing; cross veins mostly dark, even in the costal region; mediums of fore wing with four to five branches; cross veins between all branches of radius about 18 or 19; Cu_1 with three to four accessories. Length to tip of wings 70 to 80 mm; alar expanse 105 to 145 mm.

Brazil.

3 N. maculipinnis Gray

1832 Hermes maculipinnis Gray, Griffith's ed. of Cuvier, 2:531, pl.72, fig.1

1842 Neuromus ruficollis Rambur, Hist. Nat. Neur. p.443

1853 Hermes ruficollis Walker, Cat. Brit. Mus. Neur. p.202

1853 Hermes maculifera Walker, Cat. Brit. Mus. Neur. p.203

1861 Corydalis illota Hagen, Synopsis Neur. N. Am. p. 321 *(nomen nudum)*

1869 Hermes maculipinnis Gray, McLachlan, Ann. and Mag. Nat. Hist. (4), 4:39

Nearly black; mandibles black; sides of head convex, toothed angle wanting, only slightly angled on each side, back of head with black or brown shining streaks and dots, two long streaks in center, other smaller ones each side; prothorax narrower than head, longer than broad, lurid, darker at each side of center; legs and feet ferruginous; antennae longer than the thorax, slender, slightly serrated in both sexes; wings ferruginous, hyaline, white in basal part of both pairs, or in the front pair the two colors are mixed toward the base; a white spot in radiomedial region about three fourths the way out; other white spots and blotches between these spots and the white areas; media of fore wing with six branches; cross veins between all branches of radius, about 18 to 30; Cu_1 with two accessories

in both pairs of wings of both sexes. Length to tip of wings 38 to 48 mm; alar expanse 65 to 80 mm.

Brazil.

4 N. hieroglyphicus Rambur

1842 Neuromus hieroglyphicus Rambur, Hist. Nat. Neur. p.412
1853 Hermes hieroglyphicus Walker, Cat. Brit. Mus. Neur. p.206
1861 Corydalis hieroglyphicus Hagen, Synopsis Neur. N. Am. p.194
1869 Neuromus hieroglyphicus McLachlan, Ann. and Mag. Nat. Hist. (4), 4:45

Pale yellow; mandibles brown; cheeks convex, one toothed; head with two black spots behind, which fade out in some specimens; prothorax cylindric with four black or brown spots or marks; mesothorax with sometimes two to four similar marks; feet yellow, base and apex of tibiae and apex of tarsi black; antennae short, black with bases yellow; appendages of male four, superior ones the longer, apex recurved; inferior ones stout, apex clavated; wings yellowish hyaline, cross veins in front pair partly black, and those wings marked posteriorly with more or less distinct black spots; media of fore wings with three branches; cross veins between all branches of radius, about 10 to 17; Cu_1 with 1 to 2 accessories. Length to tip of wings 40 to 65 mm; alar expanse 65 to 90 mm.

Mexico, Central America, Brazil, Venezuela.

5 N. corripiens Walker

1860 Hermes corripiens Walker, Ent. Soc. Lond. Trans. n. s. 5:180
1861 Corydalis livida Hagen, Synopsis Neur. N. Am. p.321 (*nomen nudum*)
1869 Neuromus corripiens McLachlan, Ann. and Mag. Nat. Hist. (4), 4:45

General color testaceous; mandibles black, marked with dark brown; head black between the ocelli; heads slightly angled; prothorax narrower than the head, almost linear; two elongated black dots on each side, the fore pair sometimes almost obsolete; legs yellow above, darker below, tarsi blackish; antennae simple, black, testaceous toward the base; wings whitish hyaline, veins testaceous, fore pair with the cross veins more or less

black, costa very convex; media of fore wings with six branches; cross veins between all branches of radius, about 28 to 30; Cu_1 with three accessories. Length to tip of wings 60 to 65 mm; alar expanse 90mm.

Brazil.

6 **N. winthemi** n. sp.

Yellowish; mandibles reddish brown; head brownish yellow, lighter on hind part, side of head one toothed; prothorax longer than broad, dark marking indistinct; legs light yellow, last tarsal segment blackish; antennae not seen; wings whitish hyaline; veins yellow; fore pair with the cross veins and angles of veins more or less brown; cross veins between all branches of radius about 11 or 12; Cu_1 with two accessories. Length of body 32mm; to tip of wings 55mm; alar expanse 90mm.

Brazil. Collected by Winthem. Type in the Hagen collection, Museum of Comparative Zoology.

7 **N. pallidus** n. sp.

Light yellow; mandibles brownish; ocelli partly ringed with black; behind each side of head a brown raised mark; cheek with a single tooth; prothorax longer than wide, a brown interrupted streak each side, not reaching the caudal margin of the segment; legs and feet light yellow, claws darker; antennae filiform and hairy; wings transparent, obscured in the stigmatal region of all four wings; a few white scales and hairs along the veins; cross veins, at least toward base of fore wings, somewhat darkened; about 12 to 14 cross veins between all the branches of radius; media of fore wings with three branches; Cu_1 with two accessories. Length to tip of wings about 40mm; alar expanse 60 to 65 mm [pl. 52, fig. 3].

Type in United States National Museum, Washington, catalogue no. 5176; probably native of Mexico.

CORYDALIS Latreille

Adult. This genus includes the largest insects of the order. Yellow-fuscous, 40 to 60 mm long from base of jaws to end of abdomen, males usually the larger; wings fuscous with black and yellow veins; white dots always found in some of the cells

of the fore wings. Prothorax quadrangular, much narrower than the head and shorter than the mesothorax and the metathorax combined; large toothlike angles on the back part of the sides of the head; three large approximate ocelli facing at about 120° from each other; antennae filiform moniliform or slightly serrate in a few species, as long as, or much longer than the head and thorax combined; mandibles prominent, not concealed by the labrum when closed, those of the male more or less elongated and annular, incurved, suited only for clasping. Wings numerously veined, the accessory veins of the radial sector extending backward from R_2 in both pairs of wings, and media has more than two branches [fig. 26]; hind wings broad at base and folded in the anal area when at rest; wing expanse 100 to

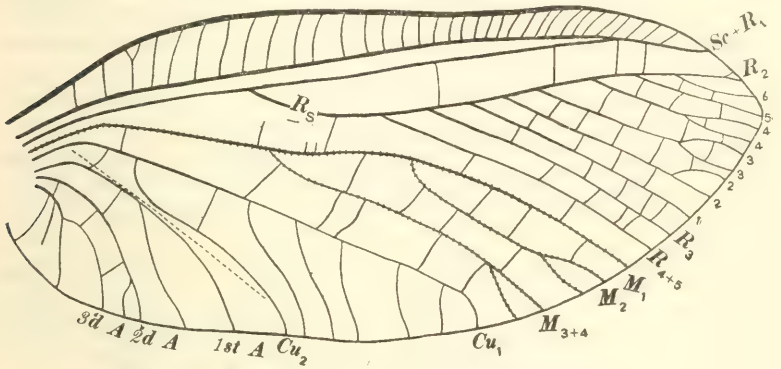

Fig. 26 Fore wing of Corydalis cornuta x2

150mm. Tarsi cylindric; male caudal appendages long and usually strongly forcipate; in the female they are short and simple.

Larva. When full grown, the larva is about 80 to 90 mm long. The general color is dusky; the head and thorax are supplied above with pretty figured markings; the whole body is supplied with black clavate projections except in the intersegmental folds and on the parts heavily clothed with chitin. The last four or five segments of the abdomen taper toward the caudal end of the body. The first eight segments of the abdomen are each provided with a pair of unjointed lateral filaments, 6 to 7 mm long, somewhat clothed with hairs; the first seven of these segments are each provided with a pair of ventral tufts of tracheal gills. Spiracles are found on each of the first eight abdominal segments and on the fold between the prothorax and the mesothorax, and a rudimentary pair on a fold between the mesothorax and the metathorax. On the last abdominal segment are

a pair of slightly two jointed anal prolegs, each with a pair of strong, slender claws and a lateral filament. The antennae have six segments, the basal joint being united with the head, though Walsh and Riley recognized only five segments.

Corydalis larvae collected from different localities have been examined. As they show some variations, a few notes on them may aid in future work of determining the species.

Label, "Colorado, Chiquili, Dr Newbery, 1873." Has no tufts of hairs on the lateral nor anal filaments. The spongy tufts are sessile as in C. cornuta. Some tufts of hairs near the spiracles on the sides of the abdomen; some yellow markings on dorsal aspect of abdomen.

Label, "Texas, Stolley, no. 1640." Has two rows of hairy tufts on most of the lateral and on the anal filaments. Thorax and head brown with some light yellow areas; abdomen dark above with no yellow markings; mesothorax and metathorax same color as the prothorax.

Label, "Mobile Ala., 1853." Has tufts the same as the above specimen, but the abdomen is very dark, and the clavate projections are usually long. Mesothorax and metathorax same color as the abdomen; prothorax and head reddish brown without the striking light markings; lateral and caudal filaments nearly white above.

Label, "Rio Negro, Amazon, Thayer Exp." (about 1869). Has the six jointed antennae, and the marks of C. cornuta on the head and thorax. It differs from that species in that the spongy tufts stand out ventrally from the abdomen, as a pair of fan-shaped tufts to each segment.

Label, "Himalaya, Sutlej river, Billispur M. M. Carleton, 1872." Very light brown or yellowish; reddish yellow on the thorax and head. The eight pairs of lateral filaments are clothed on the ventral side with tufts appearing like the tracheal tufts. A similar growth fringes the abdominal segments. Antennae six jointed; ocelli six on each side.

Eggs. The egg masses of Corydalis cornuta were described by Riley [1877] who found them in the middle of July 1876, along the banks of the Mississippi. His description I quote:

"The egg mass of Corydalis cornuta is either broadly oval, circular, or (more exceptionally) even pyriform in circumference, flat on the attached side, and plano-convex on the exposed side. It averages 21mm in length, and is covered with a white or cream-colored albuminous secretion, which is generally splashed around the mass on the leaf or other object of attachment. It contains from two to three thousand eggs, each of

which is 1.3mm long, and about one third as wide, ellipsoidal, translucent, sordid white, with a delicate shell, and surrounded and separated from the adjoining eggs by a thin layer of the same white albuminous material which covers the whole. The outer layer forms a compact arch, with the anterior ends pointing inward, and the posterior ends showing like faint dots through the white covering. Those of the marginal row lie flat on the attached surface; the others gradually diverge outwardly so that the central ones are at right angles with said object. Beneath this mantled layer the rest lie on a plane with the leaf, those touching it in concentric rows; the rest packed in irregularly. Before hatching, the dark eyes of the embryon show distinctly through the delicate shell, and the eggs assume a darker color, which contrasts more strongly with the white intervening matter.

The egg-burster (*ruptor ovi*) has the form of the common immature mushroom, and is easily perceived on the end of the vacated shell."

Prof. Riley's description of the "egg-burster" agrees exactly with the appearance of the micropylar projection, and this is the only appendage I have found on the eggs either before or after the larvae have hatched [fig.20].

The eggs are found on trees, vines, leaves, stones, bridges, etc, usually over running water, but sometimes at a very short distance to one side of the stream.

Life history of Corydalis cornuta

Riley and others have given accounts of the life history of this species, but by careful tracing I have been able to add a few points.

The young larvae of an egg mass all hatch in a single night, crawl from under the mass and soon drop or crawl to water. The young differ from the older larvae in having relatively larger heads and mouth parts, only three jointed antennae, and relatively longer filaments and legs. Riley observed that they lack the ventral spongy tracheal tufts. These tufts do not appear till a later molt. Riley therefore concluded that these tufts are for the purpose of adhering to stones, and not for breathing. The structure of these (showing tracheae), the absence of other suitable gills, the regular movements of the tufts when a larva is actively respiring, as when placed in water from which the air has escaped—all these indicate the true purpose of the tufts.

The larvae live at the bottom of streams of rapid water in the swiftest parts, under stones. They readily feed on soft bodied caddis worms, Sialis larvae, very young Chauliodes larvae, younger members of their own species; and doubtless have a wide range of food habits. I have succeeded in getting hungry larvae to eat bits of fresh beef by placing them in a tray of water in a photographic dark room. They do not feed well when exposed to bright light; and they seem to prefer live food. In the dark room they will sometimes eat large dipterous larvae.

They spend the winter some distance below the bed of the stream buried in the sand and gravel.

The larvae usually crawl when they care to move about in the water, but they can swim backward readily and sometimes are found to swim forward.

Nothing very definite is known as to the number of molts or as to the length of the larval period. The same problems are here involved as those stated on a preceding page in speaking of Chauliodes larvae. I have kept larvae of Corydalis over winter in running water in dark cells made of flowerpots. Out of 28 which were kept alive in the cells for nine months, only two were found to molt, and these do not warrant the drawing of any general conclusion. In September 1899 I took from one locality in Fall creek, Ithaca, over 100 larvae and measured their heads. The range of sizes was so gradual that it gave no clue to the probable number of years represented in the lot.

Though the larvae naturally live in beds of streams till full grown, they are capable of living out of water in moist soil for an indefinite length of time. I thus kept them in a breeding cage in a greenhouse for over four months, at the end of which they were accidentally killed. The larval spiracles are doubtless open and functional, at least when the insect is out of water, and may be used for breathing from air which collects under stones in running water.

The mature larvae leave the water in May or June and pupate in cavities under flat stones near the stream. At times they crawl for many rods and even up high banks before selecting

a suitable place to pass the pupa state. Walsh gives an account of the crawling of the mature larvae to the top of a chimney of a small house by the Mississippi river.

When the last larval skin is shed, the pupa is very light brown or nearly white, but gradually becomes darker up to the end of the period. The pupa very much resembles the adult in external structure, specially as regards the antennae, tarsal segments, wing pads, and absence of lateral filaments, spongy tufts and prolegs. There is great variation in the appearance of the warty prominences left by the bases of the filaments.

The length of the pupal life was determined by daily observation of specimens which had just crawled from the water to find a nest for the pupal life. The transformations of 25 specimens were thus noted. It was found that the time spent in the nest before the larval skin is shed varies from about one day to as much as two weeks. The time from this last molt till the adult emerges, or the actual life of the pupa, is not so variable, as the table will show.

No. of larvae observed	Date of molting larval skin	Date of emerging as adults	Days in pupal life
4	May 29	June 8	10
5	May 28	June 4	7
12	May 29	June 7	9
2	June 7	June 14	7
1	June 9	June 23	14
1	June 12	June 26	14

It will be noticed from the table that the length of life in this state varies from seven to 14 days with an average of nine days in the specimens observed. Many (perhaps 10 or 15) others, which I observed, died during that state. This was probably partly due to the fact that they were handled too much, or became too dry in the cages where they were kept, but I have often found dead pupae under stones on banks of streams.

The adults are perhaps as good fliers as Chauliodes, and both of these will make longer flights than Sialis; both are often found at great distance from streams, while Sialis seldom

wanders far from water. Corydalis is usually crepuscular, and is often attracted to lights at night. One large female was seen to make a flight of several rods, when apparently unmolested, on a bright, hot June day at 2 o'clock p. m.

The adults are very short-lived, at least when kept in cages, and probably also when at large, judging from the short length of the season when adults are to be found. Of the specimens kept in cages, the males never lived longer than three days after emerging, while the females lived as long as eight or 10 days. None could be induced to take food, and it is probable that the adults take no food. The studies made by Mr W. A. Riley and others indicate that very little histolysis takes place in the digestive organs. This is explained by the probable fact that these organs are not used in the adult insect.

The dates on which adult specimens have been taken at Ithaca range from June 4 to July 8, in a long series of years.

TABLE TO SPECIES OF CORYDALIS

a Hastate or lanceolate pale mark on middle of hind part of prothorax, irregular light marks each side	
b Costal cells of front wings mostly with two white spots in each	
c Male appendages, upper pair, with the ends abruptly turned under and back, appearing as a separate segment	1 inamabilis
cc Male appendages, with upper pair not abruptly turned backward	2 cornuta
bb Costal cells of front wings with only one white spot in each	3 cognata
aa Hastate and other marks on prothorax of same color as the rest or nearly so	
b Antennae with two basal joints and most of the others light yellow, outer three fourths with minute sharp teeth	
c Front wings with no dusky clouds in cells, except near the stigmatal region; white dots almost wanting	4 crassicornis
cc Front wings with dusky and white clouds; white dots numerous except in costal region	5 peruviana
bb Antennae with basal joints never yellow; segments of antennae never toothed	
c Costal cells often with two white dots in each	
d Front wings hardly clouded except in region of stigma	6 lutea

dd Front wings densely clouded in many places, specially just back of R_1..... 7 batesii
cc Costal cells with only one or no white dots
d Front wings with dark circle near the forking of media; triangular white spot at stigma ..... 8 nubila
dd Front wings not marked as above..... 9 armata

DESCRIPTION AND GEOGRAPHIC RANGE OF SPECIES

1 C. inamabilis McLachlan

1868 Corydalis inamabilis McLachlan, Linn. Soc. Jour. 9:235, pl.8, fig.3

Pale brown; abdomen pale fuscous; palpi black, with broad whitish yellow annulations; mandibles long, slender, finely rugose, pale brown with apical portion black; head yellowish brown, anterior margin nearly black; finely rugose above, beneath, and posteriorly with coarsely reticulated spaces; ocelli yellow; eyes plumbeous; caudal portion of head with impressed streaks and spots; prothorax longer than broad, slightly widened posteriorly; upper surface convex, pale brown, hastate median impression behind; roughened raised places along the sides; legs and feet pale yellowish brown, tarsi and tips of tibiae darker; antennae scarcely shorter than body, pale brown, three or four terminal joints black, basal joints bulbous, joints beyond basal fourth with a short triangular acute tooth; appendages of the male long, yellowish, slightly pilose; superior pair sinuate, the tips bent under and somewhat retuse; inferior pair geniculated, apexes directed upward and slightly dilated; wings long and narrow, subacute, cinereo-subhyaline; front pair with white dots in cells everywhere except in the costal area, Sc area with fuscous spaces, stigmatic region slightly yellowish, C–Sc cross veins black except those near the middle, which are whitish in the center; all discal and apical cross veins black; longitudinal veins yellow, subcosta and radius marked with fuscous; hind wings hardly paler, cross veins of discal and apical areas black, those in basal discal region yellow; front wings with about 26 cross veins between all branches of radius, media with four branches, Cu_1 with three accessories. Alar expanse 100mm; body without appendages 35mm; mandibles of male 26mm.

Waco and Dallas Tex.

2 C. cornuta Linnaeus

1758 Hemerobius cornutus Linnaeus, Syst. Nat. ed. 10. p.551
1767 Raphidia cornuta Linnaeus, Syst. Nat. ed. 12. p.916
1773 Hemerobius cornutus DeGeer, Mém. Ins. 3:559, pl.27, fig.1
1781 Hemerobius cornutus Fabricius, Sp. Ins. 1:392; and 1787. Mantissa Ins. 1:246
1788-93 Hemerobius cornutus Linnaeus, Syst. Nat. ed. 13. 5:2639
1791-1825 Corydalis cornuta Olivier, Encycl. Meth. 7:59
1793 Hemerobius cornutus Fabricius, Syst. Ent. 2:81
1805-21 Corydalis cornuta Palisot, Ins. Neur. pl.1, fig.1
1807 Corydalis cornuta Latreille, Gen. Crust. and Ins. 3:199
1836-49 Corydalis cornuta Cuvier, Règne Animal, p.14, pl.104
1839 Corydalis cornuta Burmeister, Handb. Ent. 2:950
1848 Corydalis cornutus Holdemon, Acad. Bost. Jour. p.158, pl.1-3
1861 Corydalis cornuta Hagen, Synopsis Neur. N. Am. p.192; 1863. Ent. Soc. Phila. Proc. 2:181
1863 Corydalis cornuta Walsh, Ent. Soc. Phila. Proc. 2:265
1892 Corydalis cornuta Banks, Am. Ent. Soc. Trans. 19:357
1901 Corydalis cornuta Needham, N. Y. State Mus. Bul. 47, p.550, pl.28

General color luteo-fuscous to luteo-cinereous: head large, broad, sides convex, hind part with impressed yellow spots and streaks surrounded by fuscous, each side with oblique yellow stripe beneath; mandibles never concealed by the labrum, those of the male normally much elongated and annulated; prothorax much narrower than head, longer than broad, a light colored hastate mark in the middle of the hind part, irregular yellow flat points each side; legs brownish, knees, apex and incisions of tarsi fuscous; antennae nearly moniliform, long, fuscous; superior pair of male appendages forcipated, infracted at the apex, dolabriform; wings subcinereo-hyaline; veins darker, often black, specially at their angles; C–Sc cross veins pale in middle; cells mostly supplied with white dots, the costal ones each with two white dots; in fore wing cross veins between all branches of radius, about 25 to 35, media with three to four branches, and Cu_1 with four to five accessories. Length to tip of wings about 75mm; alar expanse 100 to 140 mm. The size in both sexes is variable.

Quebec, New England, New York, Pennsylvania, Maryland, Washington D. C., Virginia, North Carolina, South Carolina, Ohio, Illinois, Missouri, Kansas, Minnesota.

3 C. cognata Hagen

1861 Corydalis cognata Hagen, Synopsis Neur. N. Am. p.193
1892 Corydalis cognata Banks, Am. Ent. Soc. Trans. 19:357

General color luteous yellow; head large, broad, sides convex, marked behind with two punctate ochraceous streaks, and a few obsolete points; prothorax almost quadrangular, a little narrower than the head, marked behind with a hastate mark in the middle and ochraceous points each side; feet and legs lurid, apex of tarsi obscurer, claws fuscous; wings yellowish hyaline, cross veins dark, front wings with a dark marking on base and apex of costal area, R_1 clouded fuscous, costal cells with one white dot, number of dots in other cells several, cross veins between all the branches of radius about nine to 11, medius with three branches, Cu_1 with three accessories. Length to tip of wings 55 to 60 mm; alar expanse 80 to 100 mm.

New Mexico, Phoenix Ariz.

4 C. crassicornis McLachlan

1868 Corydalis crassicornis McLachlan, Linn. Soc. Jour. 9:233, pl.8, fig.2

Body pale brown to yellowish; head very broad, flattened above, finely rugose, blackish around the ocelli, front margins black, ocelli yellow, head marked behind with three impressed reticulated spaces; palpi black; mandibles of male very long, blackish tubercles on inner edges, color same as head but darker near the tips; prothorax scarcely longer than broad, hardly dilated behind, brownish with front margin blackish, the hastate median mark behind, and raised spaces each side of about the same shade as the prothorax; mesothorax and metathorax nearly equal in width to each other and to the prothorax or slightly narrower than the hind margin of it; legs pale brown, tarsi, knees, and parts of the tibiae dark fuscous; antennae as long as the body or longer, thick, brown, sutures black, three to four terminal joints black, basal joints bulbous, joints beyond basal fourth with a short, straight, triangular tooth beneath; appendages of male very long, slightly pilose; superior pair nearly cylindric at base, tips dilated and truncated but suddenly

bent downward and produced toward the body into a short process; inferior pair not half so long, cylindric, curved upward at the tips; wings cinereo-hyaline, front pair with white dots in the cells, stigmatic region dark, subcostal region often dark fuscous and with paler spaces, veins yellowish, cross veins mostly black except the middle part of many toward the center of C–Sc, cross veins between all the branches of radius about 17 or 18, medius with three branches, Cu_1 with four accessory veins; hind wings scarcely paler than the others, subcostal area clouded, some of the cross veins dark. Length of body without appendages about 45mm; alar expanse 120 to 135 mm.

San Antonio Tex.

5 C. peruviana n. sp.

Body brown; head brown, finely rugose behind; mandibles darker than the head; prothorax much longer than broad, the median hastate mark behind concolor, roughened areas along each side reaching the whole length; legs and feet of same shade as the head; antennae of female slender, brown, black toward the tips; those of male stout, very long, slightly toothed, minute papillae all over, bright yellow, bases yellow, outer end black; wings subcinereo-hyaline, cross veins mostly darkened, a few of those in costal region lighter in the middle; white and dusky clouds from stigma across to middle of Cu_1, no white dots in the costal cells and none at all on the hind pair of wings; in front pair, cross veins between all the branches of radius, about 28 to 30, media with four branches, Cu_1 with five accessory veins. Length to tip of wings 80 to 85 mm; alar expanse about 130mm.

Types in Museum of Comparative Zoology; female from "head waters of Rio Rimac, Peru, in the Cordilleras"; male labeled "Guatamala purchase."

6 C. lutea Hagen

1861 Corydalis lutea Hagen, Synopsis Neur. N. Am. p.193

1861 Corydalis vetula Hagen, Synopsis Neur. N. Am. p.321 (*nomen nudum*)

1861 Corydalis armigera Hagen, Synopsis Neur. N. Am. p. 321 (*nomen nudum*)

General color luteous; head large, broad, ferruginous, the sides convex, marked behind with obsolete luteous spots; prothorax much narrower than head, longer than broad; sides of middle obsoletely impressed; concolor or luteous spots behind and at the sides; legs lurid, base of tibiae and some tarsal segments nigro-fuscous; antennae slender, light yellow to brown, dark at outer end; superior male appendages cylindric, long, oblique, truncated at apex; inferior ones recurved at the apex, clavate; wings subcinereo to luteo hyaline; cross veins dark except the middle part of those of costal region; veins luteous, partly fuscous; a few white dots, usually only one to a cell; front pair with cross veins between all branches of radius about 25, media with three branches, Cu_1 with four to five branches. Length to tip of wings 55 to 85 mm; alar expanse 110 to 140 mm.

Vera Cruz, Mexico, Brazil, Cordova, Spain.

7 C. batesii McLachlan

1868 Corydalis batesii McLachlan, Linn. Soc. Jour. 9:232, pl.8, fig.1

Color of body brown, or dusky on the abdomen; head above and beneath dark brown; mandibles of female black at tips; palpi black; head marked behind with five punctures, front margin yellow; ocelli yellow; eyes dark olivaceous; prothorax longer than broad, scarcely dilated behind, sides nearly parallel, very convex above, smooth, dull brown, with three short impressed concolor spaces behind; mesothorax and metathorax scarcely broader than the prothorax, pale brown; legs finely pilose, fuscous, paler beneath, all tarsi and the apical part of the tibiae yellowish, specially behind; antennae yellow with black tips, very slender, not toothed, not over two thirds the length of the body; wings long and narrow, front pair ashy, dusky area beyond the middle, many blackish blotches in front portion, one at stigmatic region, several in subcostal region, and others back of the radius, white dots in the cells, several angles of the veins black, cross veins mostly black except the middle parts of those in the basal half of costal region; hind

pair broader and paler than the other, some dusky clouds and black veins and cross veins near front margin.

Ega, Brazil. Type, a female, in McLachlan's collection.

8 C. nubila Erichson

1848 Corydalis nubila Erichson, Schomburgk, Reise Guiana, 3:583
1861 Corydalis nubila Hagen, Synopsis Neur. N. Am. p.321

Body dark brown to brownish yellow; head broader than the prothorax, brown on the sides back of the eyes, roughened behind; prothorax rather narrow, dull brown, concolor; legs and feet light brown; antennae black, slender, slightly toothed as in C. crassicornis, a little longer than head and thorax in the female; superior pair of male appendages bent downward; front wings subcinereo-hyaline with brown shade above anal area, a dark oval spot about the first branching of medius and white dots near by, a white triangular cloud at stigma reaching nearly through cell R_1, no white dots in costal region, cross veins mostly dark; medius with four branches, cross veins between all the branches of radius, about 20 to 22; hind wings more yellowish, and no white dots in the cells. Length to tip of wings about 60mm; alar expanse 75 to 100 mm.

British Guiana, Venezuela. One female from the latter country in the Harvard museum.

9 C. armata n. sp.

1861 Corydalis armata Hagen, Synopsis Neur. N. Am. p.321 (*nomen nudum*)
1842 Corydalis cornuta Rambur, Hist. Nat. Neur. p.440
1853 Corydalis cornuta Walker, Cat. Brit. Mus. Neur. p.208

Body brown; head brown, finely rugose; mandibles brown, with three teeth besides the apex in females; thorax longer than broad, brown all over, the median hastate mark behind concolor roughened areas along each side reaching the whole length of the segment; legs and feet lighter than the head in color; antennae slender, brown, black toward the outer end; wings subcinereo-hyaline, veins fuscous, cross veins mostly darkened, those of costal region mostly light in center; front pair dusky in stigmatic region, and sometimes near the first branching of

radius, cells of costal region partly with one white spot, never two, other cells of front pair and in apical region of hind pair with white dots; cross veins between all branches of radius in front pair, about 30 to 31, media with four branches, Cu_1 with five or six accessory veins. Length to tip of wings 75 to 85 mm; alar expanse 110 to 140 mm.

Republic of Colombia, Venezuela, Chapada, Brazil, "S. Catharina, Theresopolis, Fruhstorfer, 1887." Several specimens in the Museum of Comparative Zoology.

C. ancilla Hagen, Synopsis Neur. N. Am. p.321 (*nomen nudum*), must still remain undescribed, as the only known specimen is in the Hagen collection and is too much injured for use. This specimen is from Paraguay, and it is hoped that other specimens may be discovered there.

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EXPLANATION OF PLATES

PLATE 1

Renwick lagoon at the head of Cayuga lake, Ithaca N. Y. Characteristic shore vegetation. Photo by J. H. Comstock

PLATE 2

Renwick lagoon, open water. Photo by J. H. Comstock

PLATE 3

Upper reaches of a bayou leading from Renwick lagoon across "the flats." Photo by J. H. Comstock

PLATE 4

Two views along Fall creek, near Ithaca N. Y. (1) Forest lake, looking toward the fall where the creek enters. (2) In the bottom of the gorge; one of the many small cascades; Simulium territory. Photos by H. N. Howland

PLATE 5

Aeschna constricta Say

1 Male imago. Photo from life by J. G. Needham
2 The nymph approaching a back swimmer. Drawing by Miss Anthony

PLATE 6

Unknown caddis fly larva, eaten by Bone pond brook trout
1 Head of larva. 2 End of abdomen. 3 Case. 4, 5 and 6 Legs of one side.

PLATE 7

Callibaetis skokiana Ndm.

1 Imago
2 Nymph
Photo from life by J. G. Needham, colored by Miss Anthony, after life

PLATE 8

Epiphragma fascipennis Loew. Drawing by Miss Anthony

PLATE 9

Epiphragma fascipennis, larva and pupa. Drawings by Miss Anthony
1 Larva, lateral view, anal gills almost withdrawn into the body
2 Respiratory disk on end of abdomen of larva
3 Pupa, ventral view

PLATE 10

Diptera

Immature stages
1 Larva of an unknown Leptid from rapids
2 One of its paired bifurcated abdominal prolegs, showing grappling hooklets protruded
3 Pupa of Tipula flavicans Loew
4 Larva of an unknown Tipulid from springs
5 End of abdomen of same from above

PLATE 11

Calopteryx maculata Beauv. Male and female. Photo from life by J. G. Needham

PLATE 12

Hetaerina americana, executed from nature, under the author's direction, by L. H. Joutel

1 and 2 Males
3 Female
4 and 5 Cast nymph skins
6 and 7 Nymphs in the rapids

PLATE 13

Chromagrion conditum and Argia violacea

1 and 2 Resting and flying attitudes of C. conditum. 3 Nymph of same
4 Argia violacea male. 5 Nymph of same

PLATE 14

Labia of Zygopterous nymphs

a Labium of Calopteryx maculata. *b* Labium of Hetaerina americana. *c* Labium of Lestes rectangularis, right lateral lobe omitted. *d* Left lateral lobe of same, more enlarged. *e* Labium of Argia sp.?, right lateral lobe omitted, portion of spinulose edge of median lobe shown highly magnified above. *f* Right lateral lobe of same more enlarged. *g* Right lateral lobe of labium of Chromagrion conditum. *h* Right lateral lobe of labium of Amphiagrion saucium. *i* Left lateral lobe of labium of Nehallennia irene. *j* Right lateral lobe of labium of Anomalagrion hastatum.

PLATE 15

Median caudal gills of Zygopterous nymphs

a Argia tibialis. *b* Chromagrion conditum. *c* Amphiagrion saucium. *d* Nehallennia irene. *e* Anomalagrion hastatum.

PLATE 16

Zygoptera

1 Lestes uncata Kirby. Photo from life by J. G. Needham
2 Enallagma exsulans Hagen. Photo from life by J. G. Needham
3 Drawing of nymph of Enallagma carunculatum Morse
4 Immature nymph of Enallagma antennatum Say. Photo from alcoholic specimen by J. G. Needham
5 Ischnura verticalis Say. Photo from alcoholic specimen

PLATE 17

Agrioninae

Drawings by Mrs J. G. Needham
1 Argia apicalis Say
2 Enallagma signatum Hagen
3 Enallagma carunculatum Morse
4 (male) and 5 (female) Ischnura verticalis Say

PLATE 18

Zygoptera

Photos from alcoholic specimens by Lee C. Stiles
1 and 2 Amphiagrion saucium Burm. male and female
3 and 4 Nehallennia irene Hagen. male and female
5 and 6 Anomalagrion hastatum Say. male and female
7 Nymph of A. saucium
8 Wing of Lestes rectangularis Say

PLATE 19

Enallagma

Male abdominal appendages of New York species
a E. annexum. *b* E. hageni. *c* E. geminatum. *d* E. piscinarium. *e* E. divagans. *f* E. exsulans. *g* E. ebrium. *h* E. carunculatum. *i* E. civile. *j* E. aspersum. *k* E. traviatum. *l* E. antennatum. *m* E. signatum. *n* E. pollutum.

List of abbreviations for plates 20-31

a	Cocoons from which adults have emerged
al	Alimentary canal
as	Anterior sclerite
ast	Anterior sternal setae
at	Anterior tergal setae
bh	Breathing holes
c	Cuticle
ccp	Cavity surrounding the cuticular pocket
cp	Cuticular pocket
cs	Caudal spine
css	Holes made by the caudal spines
d	Dorsum
da	Dorsal apodeme
dc	Dorsal cavity
ds	Distal setae of the labrum
e	Holes eaten in the stems by larvae
ec	Empty cavities
ex	Location supposed opening in the paired dorsal cavities
h	Hypodermis
hcp	Hypodermis of the cuticular pocket
is	Infraspiracular setae
l	Lamellae
lg	Leg
ln	Lumen
lr	Lumen respiratory system
ls	Lateral setae
m	Muscle
md	Median setae of the labrum
mg	Marginal setae of the labrum
ms	Mesothorax
mt	Metathorax
o	Cocoons

os Opening of the spiracle
p Pleura
pc Peripheral layer of chitin of the caudal spines
pdc Paired dorsal cavities
pe Peritreme
pf Prothoracic filaments
pr Prothorax
ps Pedal setae
pst Posterior sternal setae
pt Posterior tergal setae
pvc Paired ventral cavities
px Proximal setae of the labrum
r Denuded roots
rec Rectum
s Spiracle
sn Sensory spots
ss Supraspiracular setae
st Sternal setae
t Tracheal taenidia
tr Trachea
ttr Transverse tracheal trunk
v Venter
vc Ventral cavity
vh Vacuolated hypodermal cells
vv Ventral border paired ventral cavities
w Cuticular wedge paired ventral cavities
x Leaf stalks
y Scars of shed leaf stalks
z Larvae

PLATE 20

View near the outlet of the Renwick lagoon, looking southeast. Photo by J. H. Comstock

PLATE 21

1 Portion of leaf of Nymphaea advena, showing eggs of Donacia palmata. Photo by J. G. Needham
2 Portion of leaf of a sedge, showing the eggs of Donacia porosicollis
3 Eggs of Donacia cincticornis
4 A single egg mass of Donacia palmata

PLATE 22

Underground stem of Nymphaea advena, showing larvae and cocoons of Donacia palmata. Photo by J. O. Martin

PLATE 23

Plant of Sparganium androcladium. Photo by J. G. Needham

a Summit of the plant with beetle on the leaf. *b* Roots as withdrawn from the water, showing cocoons of Donacia emarginata near the base of the leaves

PLATE 24

Sections of the stem of Sagittaria

1 Cross section. 2 Longitudinal section, both showing intercellular spaces and arrangement of tissues

3, 4 Eggs of Donacia porosicollis

PLATE 25

Donacia

Anatomic details of the larvae. Enlarged

DONACIA CINCTICORNIS

1 Mandibles. 2 Antennae. 3 Leg. 4 Maxilla. 5 Labium. 6 Labrum

DONACIA PALMATA

7 Maxilla. 8 Antenna. 9 Labrum. 10 Eyes. 11 Mandibles. 12 Leg

DONACIA SUBTILIS

13 Eye. 14 Leg. 15 Mandibles. 16 Maxilla. 17 Labrum. 18 Labium. 19 Antenna

PLATE 26

Donacia

Anatomic details of the larvae. Enlarged

DONACIA POROSICOLLIS

1 Mandibles. 2 Maxilla. 3 Labrum. 4 Labium. 5 Leg. 6 Eyes. 7 Antenna

DONACIA AEQUALIS

8 Mandibles. 9 Maxilla. 10 Antenna. 11 Labrum. 12 Leg

DONACIA EMARGINATA

13 Labrum. 14 Antenna. 15 Labium. 16 Maxilla. 17 Leg. 18 Mandibles

PLATE 27

Haemonia, Galerucella and Donacia palmata

Anatomic details of the larvae

HAEMONIA NIGRICORNIS

1 Mandibles. 2 Labrum. 3 Labium. 4 Leg. 5 Eyes. 6 Maxilla. 7 Antenna

GALERUCELLA NYMPHAEAE

8 Mandibles. 9 Labrum. 10 Leg. 11 Labium. 12 Maxilla

DONACIA PALMATA

13 Larva just emerged from the egg. 14 Dorsal apodeme. 15 Longitudinal section of a trachea. 16 Surface section of trachea showing taenidia. 17 Lateral view of apex of abdomen of mature larva. 18 Portion of a stem of Nymphaea advena with a mature larva feeding with its head and thorax buried in the tissues of the plant. 19 Dorsal aspect of the four apical abdominal segments of a mature larva

PLATE 28

Donacia palmata

Anatomic details of the caudal abdominal spiracle. Enlarged

1 Portion of a stem of Nymphaea advena with a mature larva attached to it by its caudal spines, in the act of respiring

2 Lateral view of a caudal spine and its internal attachment

3 Apex of a caudal spine still more enlarged

4 A transection of a caudal spine at the level *d–e* of figure 2

5 A transection of a caudal spine at the level *f–g* of figure 2

6 A transection near the base of the caudal spines
7 A transection through the cephalis end of a cuticular pocket
8 A sagittal section through the base of a caudal spine and its cuticular pocket laterad of the spiracular opening
9 A transection of a cuticular pocket taken at about the level *n–o* of figure 8
10 A transection through the spiracular opening
11 A transection taken caudad of the spiracular opening
12 A transection of a cuticular pocket, showing its connection with a trachea
13 A transection of a cuticular pocket taken cephalad of the spiracular opening
14 A section through the transverse connection of the tracheal trunks and the dorsal apodeme
15 A portion of the hypodermis and some cuticular plates greatly enlarged
16 Some cuticular plates still more enlarged
17 A sagittal section through the apex of the abdomen of a mature larva mesad of a spiracular opening.

PLATE 29

Donacia

Setal arrangement of the larvae
1 Donacia cincticornis
2 Donacia palmata
3 Donacia subtilis
4 Donacia porosicollis

PLATE 30

Donacia and Haemonia

Setal arrangement of the larvae
1 Donacia aequalis
2 Donacia emarginata
3 Haemonia nigricornis
Anatomic details of Donacia palmata
4 Lateral view of the abdomen of the adult female
5 Dorsal view of the same
6 Portion of a rhizome of Nymphaea advena, showing the attachment of the cocoon

PLATE 31

The food plant, Brasenia peltata, and transformations of Galerucella nymphaeae. Drawn by Miss Anthony

PLATE 32

Simulium territory

A little fall in the bottom of Cascadilla gorge.

PLATE 33

Simulium meridionale

1 Mandible of larva. x110
2 Maxilla of larva. x110
3 Hypopharynx of larva. x110
4 Labium of larva. x190
5 Respiratory filaments of pupa. x40

Simulium pecuarum

6 Mandible of larva. x110
7 Hypopharynx of larva. x110
8 Labium of larva. x190
9 Maxilla of larva. x110
10 Respiratory filaments of pupa. No scale
11 Labrum of larva. x110

PLATE 34

Simulium hirtipes

1 Wing of male. x15. *C* Costa. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus. *A* Anal
2 Palpus of adult. Female. x40
3 Maxilla of larva. x110
4 Labium of larva. x110
5 Antenna of larva. x110
6 Mandible of larva. x110
7 Ventral view of head of larva. No scale. *lr* Labrum. *m* Mandible. *x* Maxilla. *l* Labium. *f* Fan
8 One ray of fan of larva. No scale
9 Larva. x6
10 Pupa. x6
11 Ventral view of caudal disk. x6
12 One of the radial rows of hooks of caudal disk. No scale
13 Pupal respiratory filaments. No scale

PLATE 35

Simulium vittatum

1 Respiratory filaments of pupa. x40
2 Labium of larva. x190
3 Mandible of larva. x110

Simulium sp.

From California, Santa Cruz mountains
4 Respiratory filaments of pupa. No scale
5 Pupal case. No scale
6 Mandible of larva. x110
7 Labium of larva. x190

From Leland Stanford jr University campus
8 Labium of larva. x190

From Las Vegas N. M.
9 Antenna. x190
10 Labium. x110

PLATE 36

Simulium pictipes

1 Mandible of larva. x110
2 Maxilla of larva. x110
3 Labium of larva. x110
4 Hypopharynx of larva. x110
5 Labrum of larva. x110

6 Cross section of hypopharynx. x110
7 Wing of male. x15
8 Thoracic respiratory filaments of pupa. x15

PLATE 37

Simulium venustum and varieties

1 Maxilla of larva. x110
2 Hypopharynx of larva, var. piscicidium. x110
3 Labrum of larva, venustum. x110
4 Respiratory filaments of pupa. x40
5 Labium of larva, var. piscicidium. x190
6 Labium of larva, venustum. x190
7 Respiratory filaments of pupa, var. piscicidium. x110
8 Wing of imago, var. a
9 Caudal appendages (blood gills) of larva, var. a. x110
10 Hypopharynx of larva, var. a. x110
11 Thoracic respiratory filaments of pupa, var. a. x110
12 Labrum of larva, var. a. x110
13 Mandible of larva, var. a. x110
14 Labium of larva, var. a. x190

PLATE 38

Legs. x50; claws. x190

1 S. venustum (var. piscicidium). Hind tarsus of male
2 S. venustum (var. piscicidium). Middle tarsus of male
3 S. venustum (var. piscicidium). Fore tarsus of male
4 S. venustum (var. a) Fore tarsus of female
5 S. venustum (var. a) Middle tarsus of female
6 S. venustum (var. a) Hind metatarsus of male
7 S. pecuarum. Hind metatarsus of female
8 S. pictipes. Hind metatarsus of male
9 S. vittatum. Hind metatarsus of female
10 S. hirtipes. Hind metatarsus of female
11 S. hirtipes. Hind metatarsus of male
12 S. meridionale. Male and female metatarsus
13 S. bracteatum. Female metatarsus
14 S. pecuarum. Claw of female
15 S. bracteatum. Claw of female
16 S. meridionale. Claw of female
17 S. pictipes. Male
18 S. meridionale. Male
19 S. venustum, var. piscicidium. Female
20 S. pictipes. Female
21 S. ochraceum. Hind metatarsus of female

PLATE 39

Corethra plumicornis

1 Larva of C. plumicornis. x12
2 Pupa of same. x12
2a Breathing tube of pupa. x110

3 Ventral view of head. x40. *e* Labium. *x* Maxillae
4 Lateral view of head, larva. *a* Antennae. *b* Filaments of third metamere of Meinert. *c* Leaflike appendages. *l* Labrum. *f* Fans. *m* Mandibles. *x* Maxilla
5 Swimming paddles of pupa. x15
6 Anal segment of larva. x40
7 Head of female. x15
8 Genitalia of male. x40
9 Wing of female. x15. *C* Costa. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus. *A* Anal
10 Wing of male. x15
11 Wing of C. albipes n. sp. x15

PLATE 40

Corethrella brakeleyi Coquillett

1 Full grown larva, dorsal view. x25. *a* Antenna. *b* Lateral sclerite of the head showing the spines. *d* Dorsal sclerite of the head
2 Ventral view of larval head. x25. *lr* Labrum. *md* Mandible. *b* Lateral sclerite of the head. *l* Labium
3 Antenna of larva. x110
4 Labrum of larva. x110
5 Larval mouth parts, ventral view. x110. *md* Mandibles. *mx* Maxilla: *i* Ventral lobe of the maxilla (perhaps cephalic prolongation of the head sclerite; *l* Labium
6 Dorsal view of left mandible of larva. x110
7 Fifth tarsal joint and claws of hind foot of adult male. x190
8 Antenna of adult male. x37½
9 Wing, denuded of hair. Female. x48
10 Last four abdominal segments of pupa. x37½

Culex sylvestris

11 Long claws of middle foot of male. x190
12 One of the claspers of the male. x48

PLATE 41

Pelorempis n. gen.

1 Larva, ventral view. Thorax and abdomen diagrammatic. x7
2 Head of same, dorsal view. x7
3 Mouth parts, ventral view. x40. *l* Labium. *x* Maxillae. *m* Mandible
4 Dorsal aspect of breathing apparatus on the eighth segment. x20. *s* Spiracle
5 Dorsal aspect of left mandible. x40
6 Dorsal aspect of labrum
7 Swimming paddles of the pupa. x7
8 Pupa. x7
9 A scale from upper surface of the labrum
10 Head of female
11 Lateral aspect of head. Female
12 Fore tarsal claw of female
13 Fore tarsus of female
14 Wing of female. *C* Costa. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus

PLATE 42

Anopheles punctipennis

1 Breathing apparatus on eighth segment, dorsal aspect. *s* Spiracle
2 Dorsal aspect of thorax and first abdominal segment. x15
3 Ventral aspect of head. x40. *l* Labium. *x* Maxillae. *p* Palpus. *m* Mandible
4 Lateral aspect of ninth abdominal segment
4*a* Palmate hairs on sides of the third to seventh abdominal segments
5 Wing of female
6 Dorsal aspect of the larval head. x40
7 Mandible of the larva. x110
8 Wing of Psorophora ciliata. Male
9 Wing of A. maculipennis female. *C* Costa. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus
10 Genitalia of male. x110
11 Breathing trumpet of pupa. x50

PLATE 43

Culex pipiens L.

1 Anal end of larva. x15
2 Head of larva. x15
3 Antenna of larva. x50
4 Dissection of ventral part of head, showing mouth parts. x50 *m* Mandible. *x* Maxilla. *l* Labium. *h* Hypopharynx
5 Ventral aspect of the upper lip. *lr* Labrum. *f* Fans. *e* Epipharynx. x50
6 Swimming paddles of pupa. x40
7 Pupa. x12
8 Fore tarsal claw of male. x110
9 Fore tarsal claw of female. x110
10 Wing of male. x15
11 Male genitalia. x50
12 Wing of female. x15. *C* Costa. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus

PLATE 44

Culex restuans

1 Labium of larva. x190
2 Mandible. x110. *s* Serrate spine
3 Dorsal aspect of head and thorax. x15
4 Antenna. x110
5 Dorsal aspect of hypopharynx. x400
6 Ventral aspect of epipharynx. x110
7 Caudal end of larva. x15
8 Dorsal aspect of labrum. *c* Clypeus
9 Wing of male
10 Wing of female
11 Breathing trumpet of pupa. x50
12 Palpus of adult male. x15
13 Palpus of adult female. x50

PLATE 45

Culex cantans Meigen

1 Ventral aspect of mandible. x110. Larva
2 Dorsal aspect of mandible. x110
3 Maxilla with palpus. Larva
4 Antenna of larva. x110
5 Serrate spine of the breathing tube, of larva
6 Caudal end of larva. x15
7 Dorsal aspect of thorax. Larva
8 Third, fourth and fifth fore tarsal joints of the male. x50
9 Wing of the male. *C* Costa. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus. *A* Anal vein
10 Long claw on middle foot of male

PLATE 46

Culex triseriatus Say

1 Antenna of the larva
2 Mandible, dorsal aspect. x110
3 Dorsal aspect of the head and thorax of larva. x15
4 Labium of larva. x190
5 Caudal end of larva, lateral aspect. x15
6 Hypopharynx of larva, conventionalized
7 Wing of female. *C* Costa. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus

Uranotaenia sapphirina O. S.

8 Dorsal aspect of larva. After Dyar
9 Caudal end of larva. After Dyar
10 Antenna of larva. After Dyar
11 Pupa. After Dyar
12 Male genitalia, lateral aspect. x110
13 Wing of female
14 Wing of male
15 Fourth and fifth tarsal joint of middle leg of the male

PLATE 47

Aedes smithii Coquillett

1 Antenna of larva. x110
2 Dissection of ventral part of the larval head, showing the mouth parts. x110. *m* Mandibles. *x* Maxillae. *l* Labium
3 Dorsal aspect of the larva. x18
4 Breathing trumpet of the pupa. x50
5 Swimming paddles of pupa. x15
6 Caudal end of the larva. x15

Diamesa waltlii Meigen

7 Antennae of the female. x50
8 Dorsal aspect of the male genitalia. x50
9 Wing of the female. *C* Costa. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus
10 Male genitalia, ventral aspect. x50
11 Fore foot of the female

PLATE 48

Dixa modesta n. sp.

1 Ventral surface of larval head. x50. *l* Labrum. *a* Antenna. *mx* Maxilla with its palpus
2 Mandible of the larva. x190
3 Maxilla and its palpus, *p*. x115
4 Pupa. x15
5 Larva, ventral view. x15. *a* Ventral caudal lobe. *b* Ventral foot bristles. *c* Abdominal prolegs
6 Dorsal view of the dorsal head sclerite. x60
7 Dorsal view of the caudal appendages of the larva. x40. *p* "Triangular chitinized plate." *s* Spiracles
8 Wing of the imago. x15. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus. *A* Anal

Diamesa waltlii Meigen

9 Ventral view of the labrum of the larva. x190. *j* Jointed appendages. *e* Epipharynx
10 Ventral view of the labium of the larva. x190
11 Larval antenna. x190
12 Larval mandible. x190
13 Pupa. x12

PLATE 49

Chironomus sp.

1 Hypopharynx of the larva. x110
2 Antenna of the larva. x190
3 Ventral aspect of the upper lip, showing the epipharynx. x110
4 Head and thorax of larva, showing the thoracic proleg. x15
5 Ventral aspect of the head. *mn* Mandible. *mx* Maxillae. *l* Labium. x50
6 Mandible. x110
7 Caudal end of larva, with its anal prolegs. x15
8 Frontal aspect of the larval head. x50. *lr* Labrum. *m* Mandible. *a* Antenna. *l* Labium
9 Dorsal aspect of the larval maxilla. x190
10 Ventral aspect of seventh, eighth and ninth abdominal segments of pupa
11 Genitalia of the male. x50
12 Pupa

PLATE 50

Thalassomyia obscura n. sp.

1 Antenna of the larva. x190
2 Ventral aspect of the larval mandible. x190
3 Ventral aspect of the upper lip (labrum). x190. *e* Epipharynx
4 Dorsal aspect of the head. x50
5 Dorsal aspect of the larval hypopharynx. x190
6 Ventral aspect of the larval maxilla. x190
7 Armature of the thoracic prolegs. x400
8 Labium of the larva. x190
9 A claw from the anal prolegs of the larva. x400
10 Pupa
11 Armature of the abdominal segments of the pupa

12 Anal end of the larva with its prolegs. x50
13 Dorsal aspect of the male genitalia. x50
14 Foot of middle leg of female
15 Wing of male. *C* Costa. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus

PLATE 51

Sialis infumata

1 and 2 Eggs
3 Lateral filaments of the larva (photomicrographs).

PLATE 52

Corydalinae

Imagos and eggs
1 Chauliodes serricornis ♂. Natural size
2 Eggs of Chauliodes sp.? Enlarged
3 Neuromus pallidus ♂. One-sixth enlarged

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[1] Electros from Needham's *Out-door Studies* for plate 16, fig. 6, plate 17, fig. 3 and 5 and text figures 3 and 7 have been kindly loaned for use in this report by the American Book Co.

Renwick lagoon, shore vegetation

Renwick lagoon, open water

Plate 3

Bayou off Renwick lagoon

Views along Fall creek

1

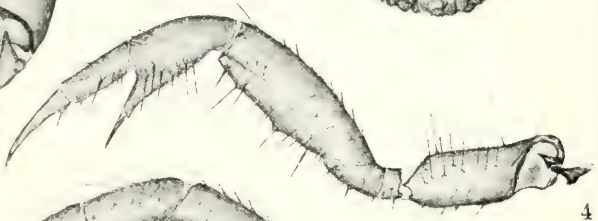
2

Dragon fly and larva (Aeschna constricta)

1

3

2



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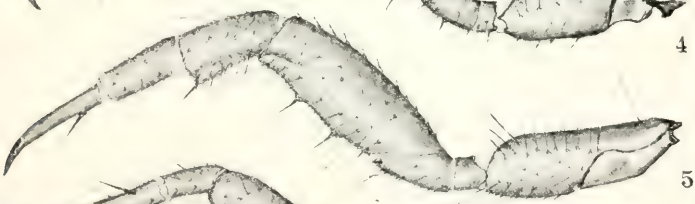

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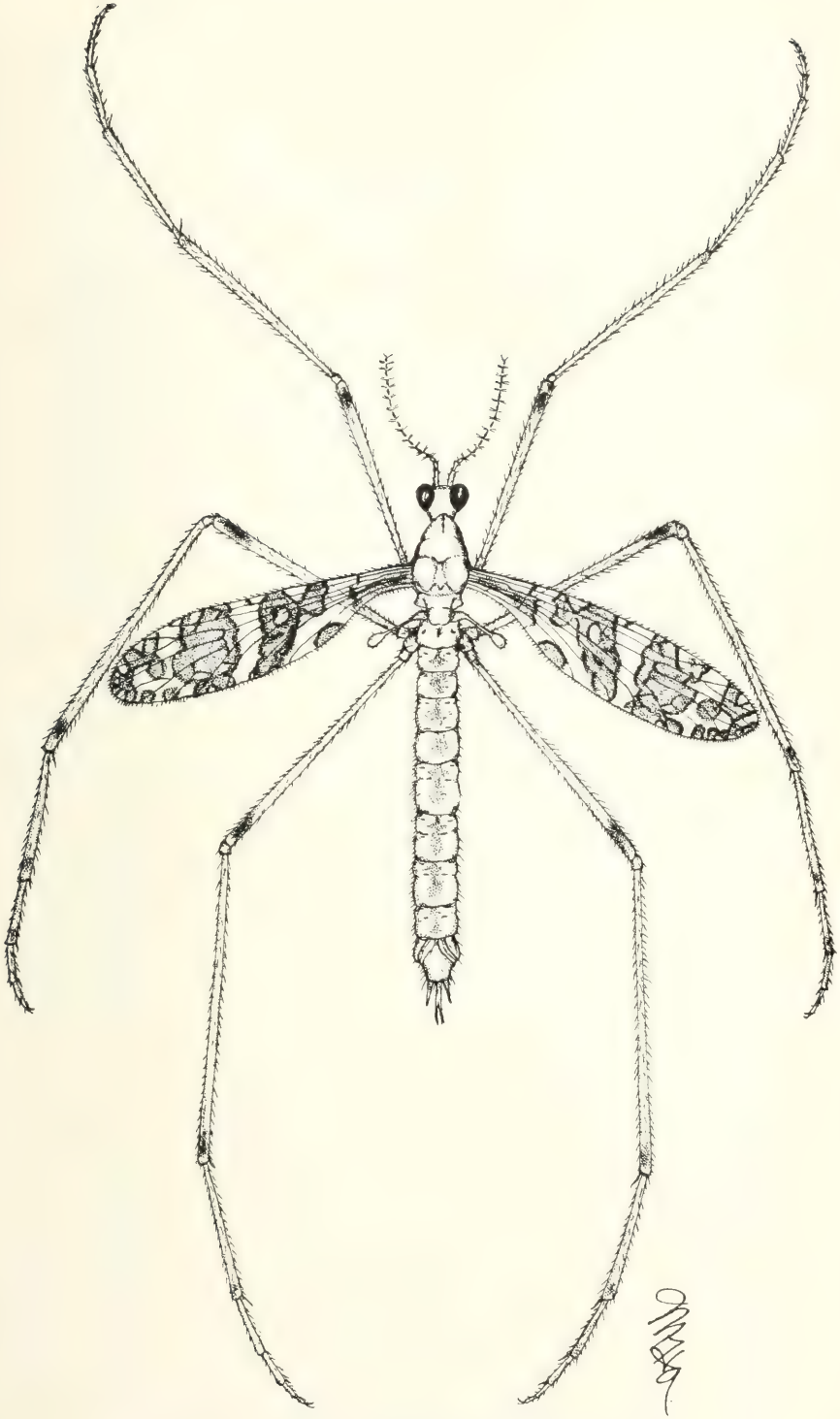
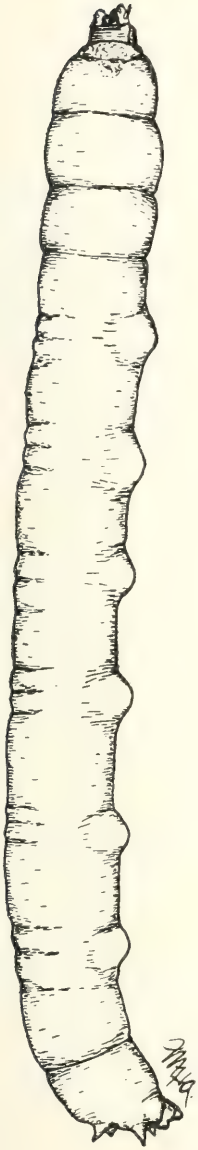
Caddis worm: brook trout food

Callibaetis skokiana



Crane fly (Epiphragma fascipennis)



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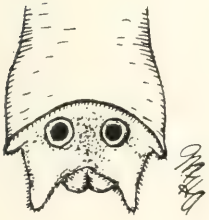

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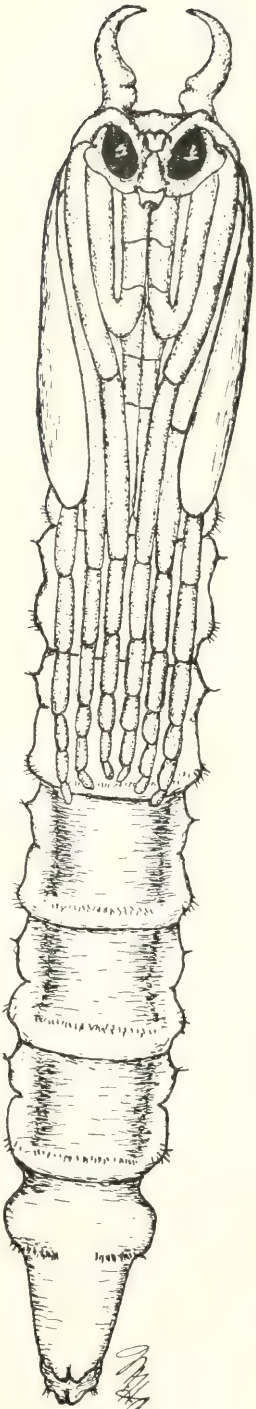

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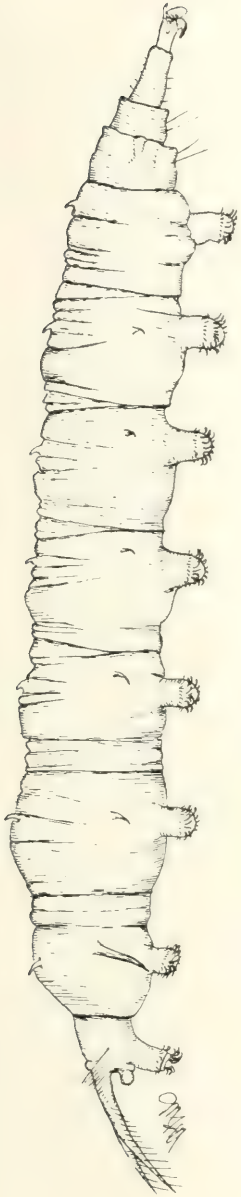
Larva and pupa of crane fly (Epiphragma fascipennis)



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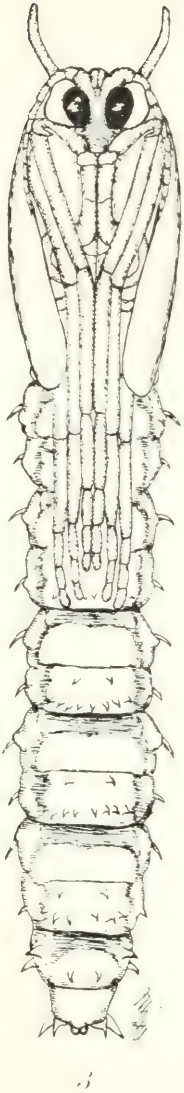

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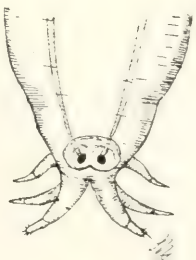

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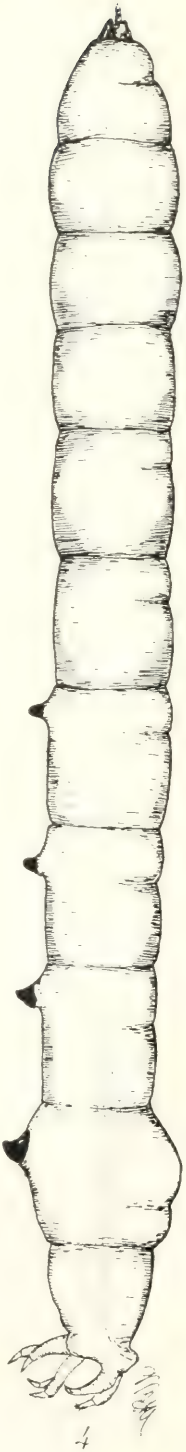


4

Larvae and pupa of Diptera

Plate 11

♀ ♂

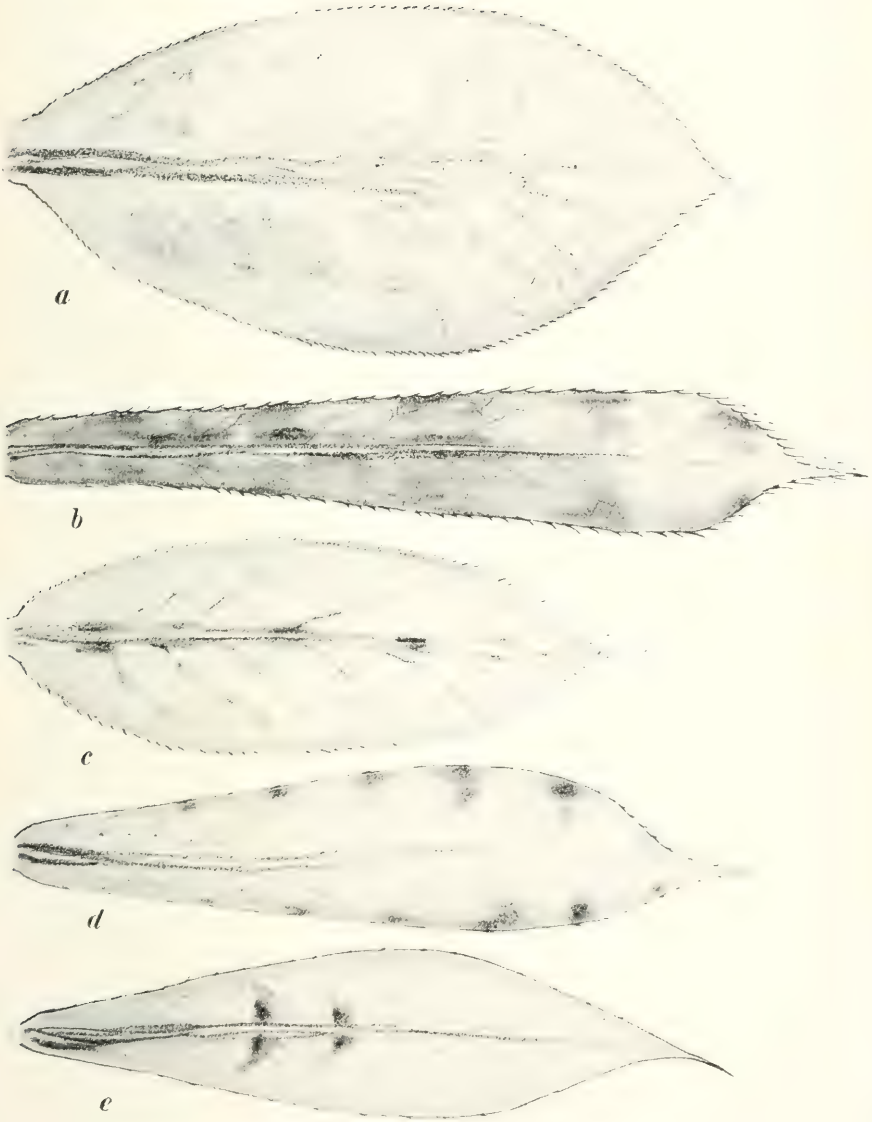
Black-wings (*Calopteryx maculata*)

L. H. Joutel, 1902

Hetaerina americana

Chromagrion conditum and Argia violacea

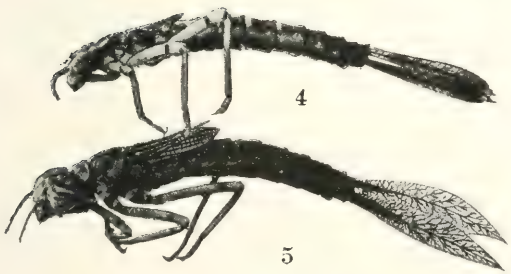
Labia of damsel fly nymphs



Median gill plates of damsel fly nymphs

1

2



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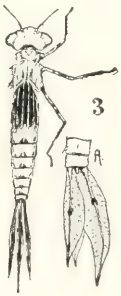

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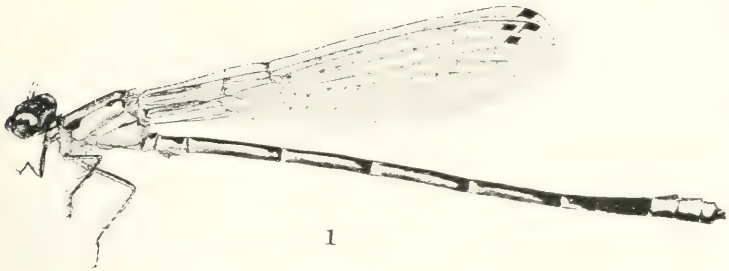
Damsel flies



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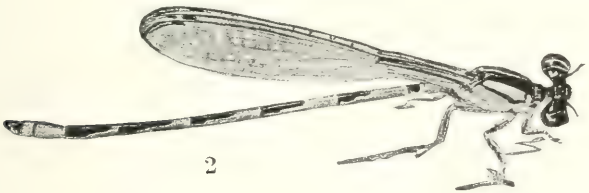

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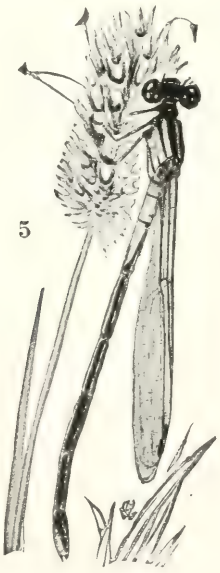

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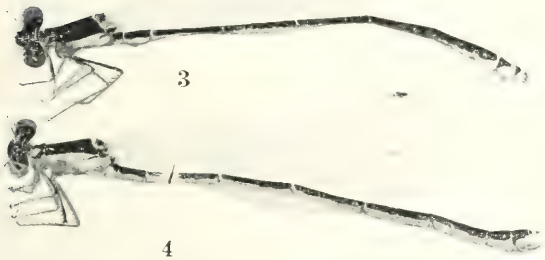
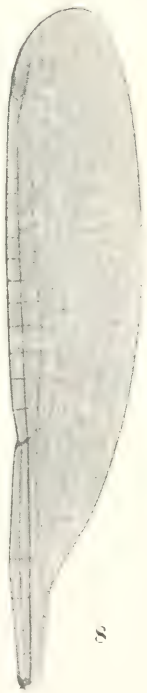
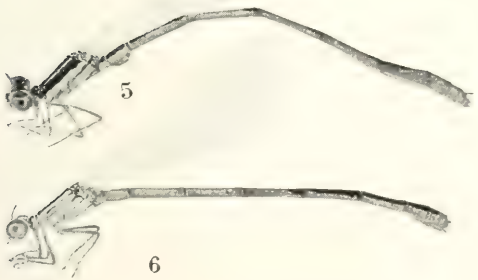
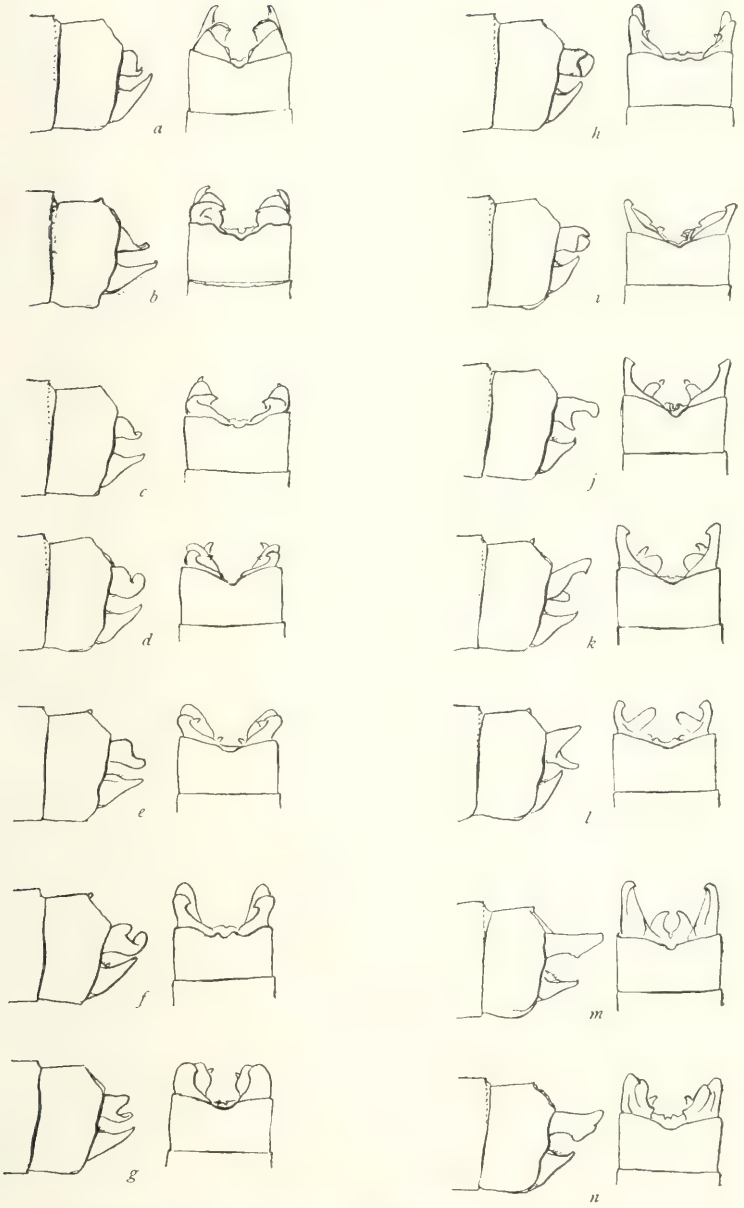
Damsel flies





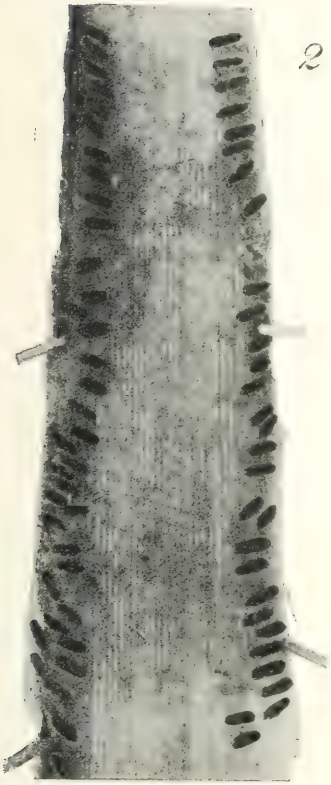


Damsel flies



Abdominal appendages of New York species of Enallagma

View near the outlet of Renwick lagoon, looking southeast



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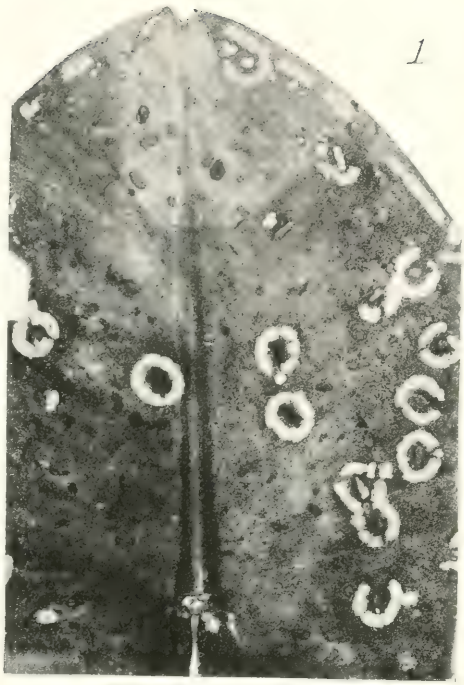

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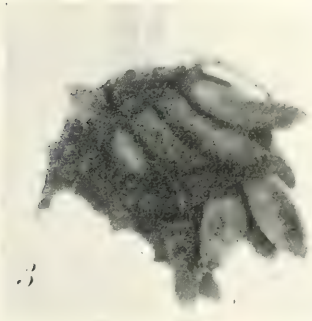

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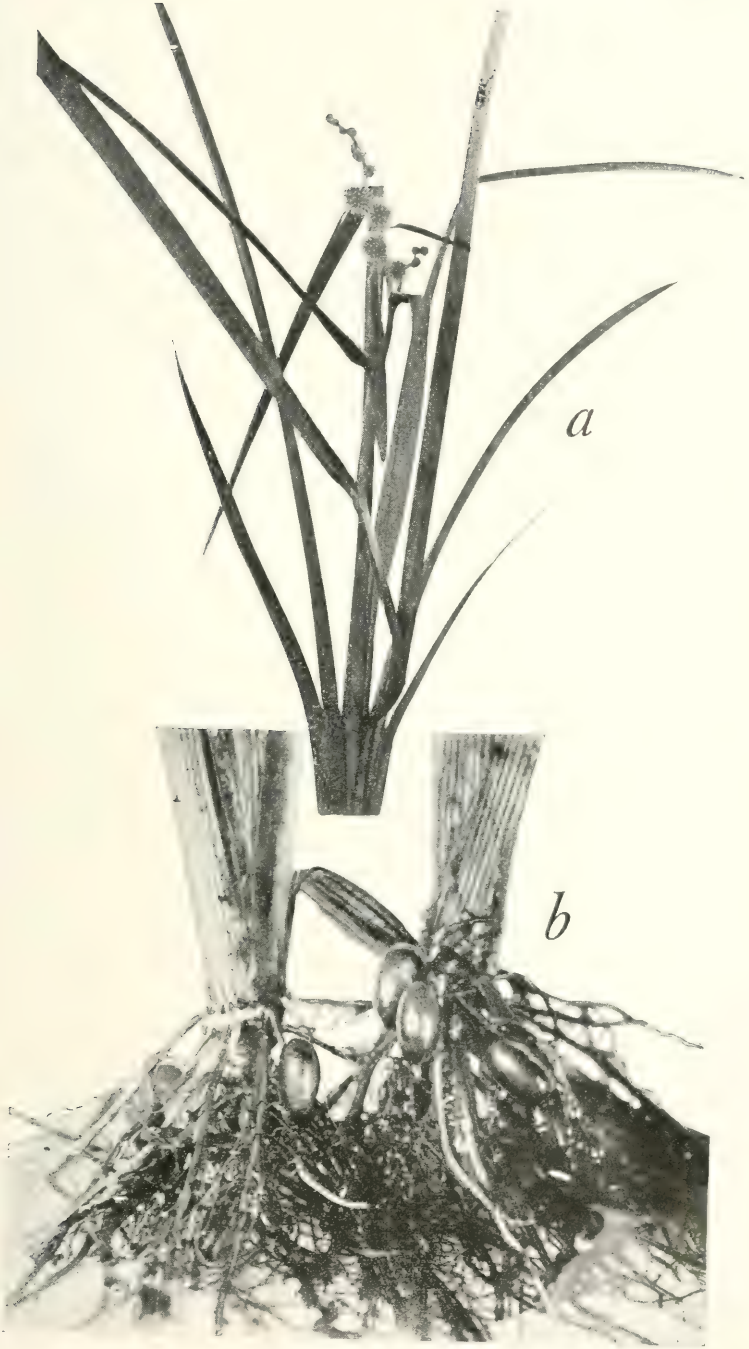
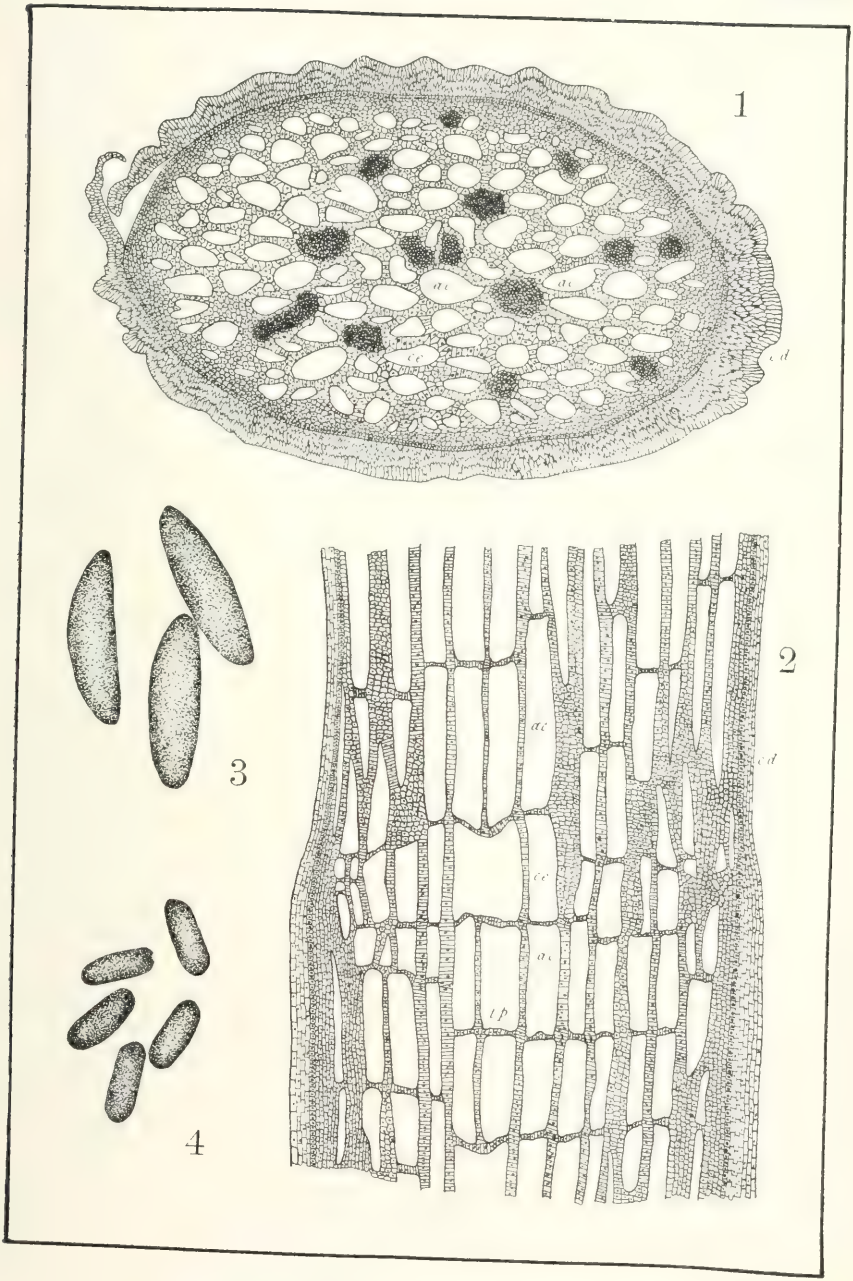
Eggs of Donacia

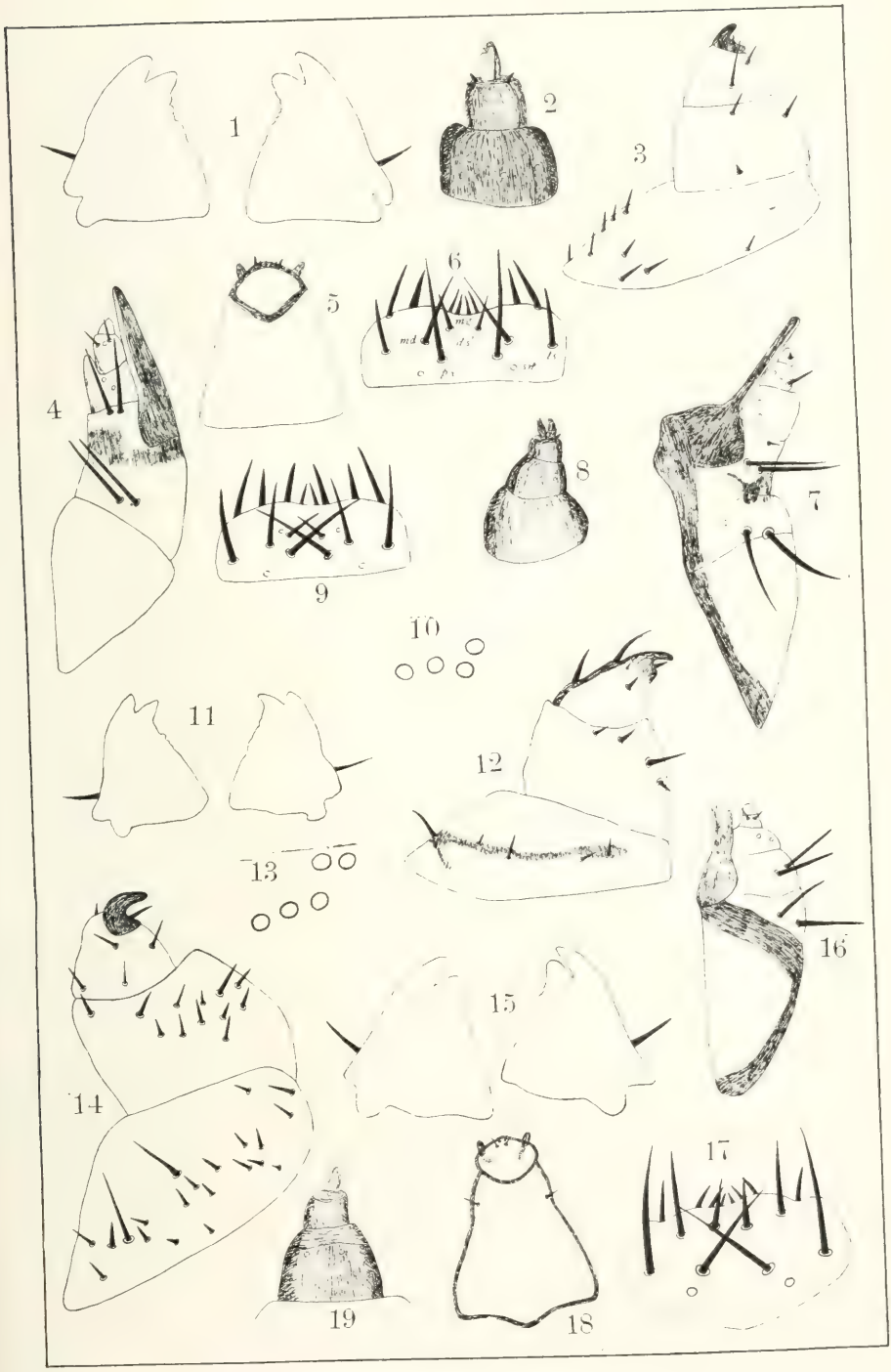
Root stalk of Nymphaea advena with larvae and cocoons of Donacia palmata attached



Sparganium with long horned leaf beetles (Donacia): larval and pupal cases on the roots

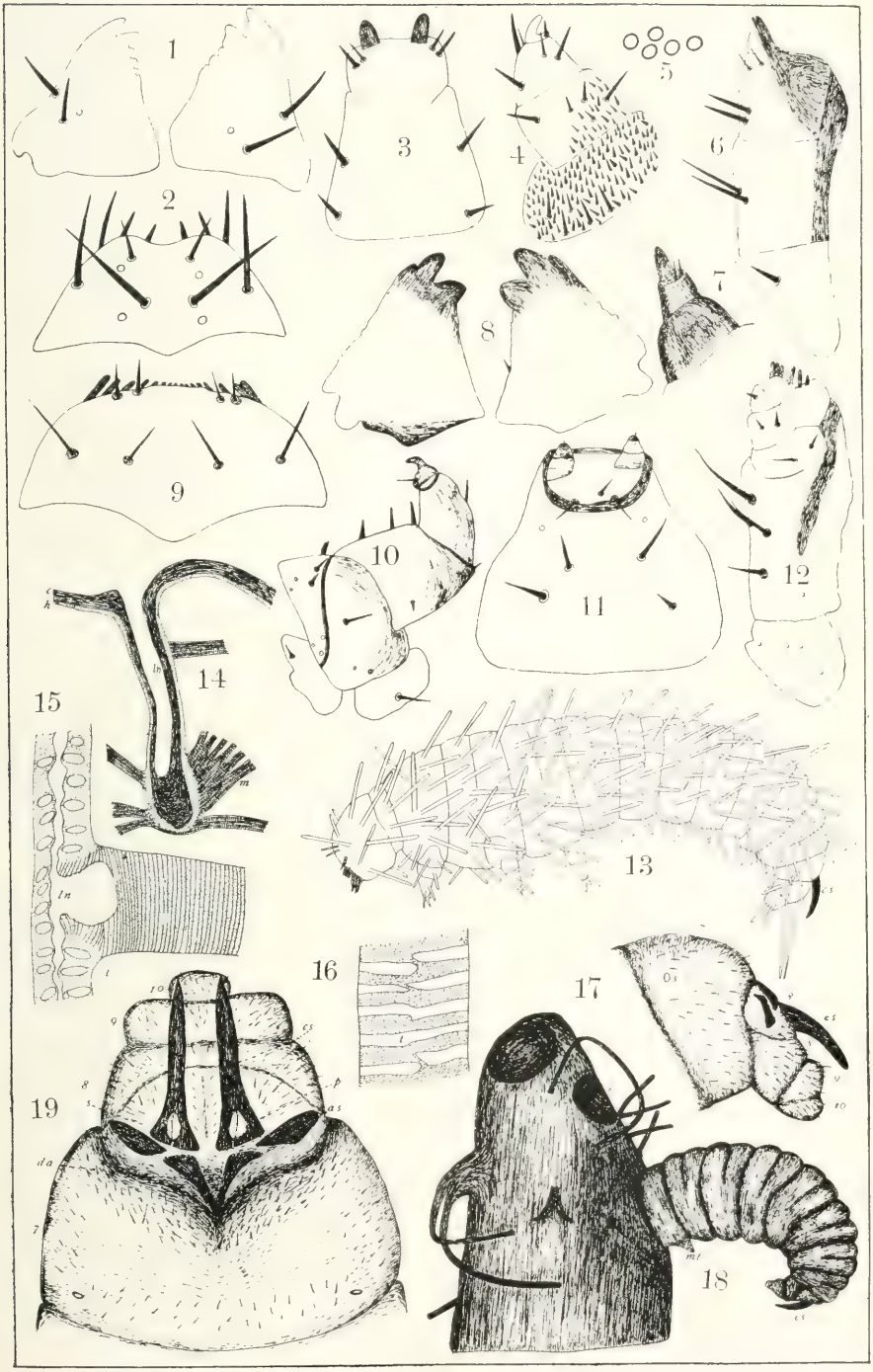


Sections of stem of Sagittaria and eggs of Donacia

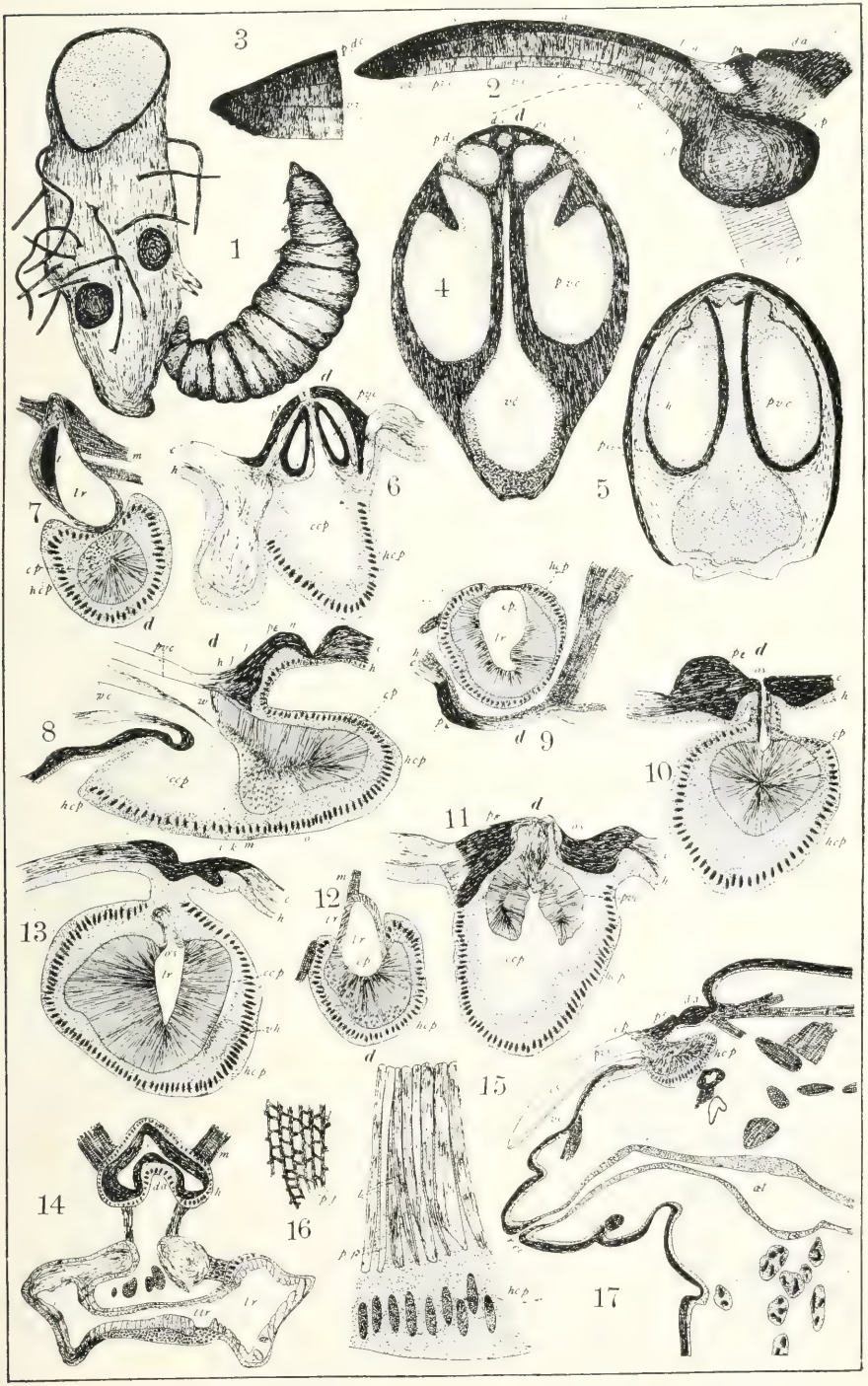


Anatomic details of Donacia larvae

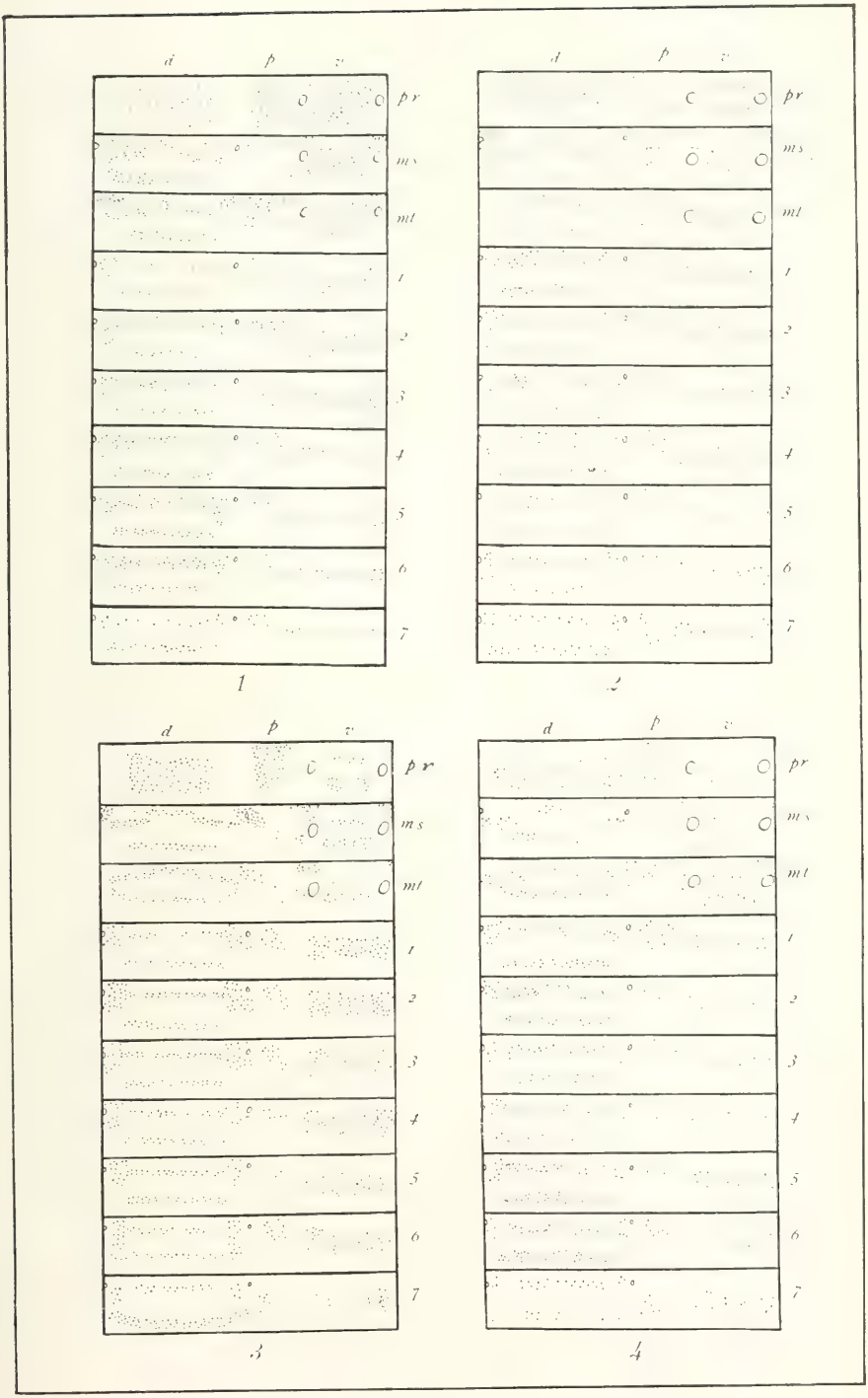
Anatomic details of Donacia larvae



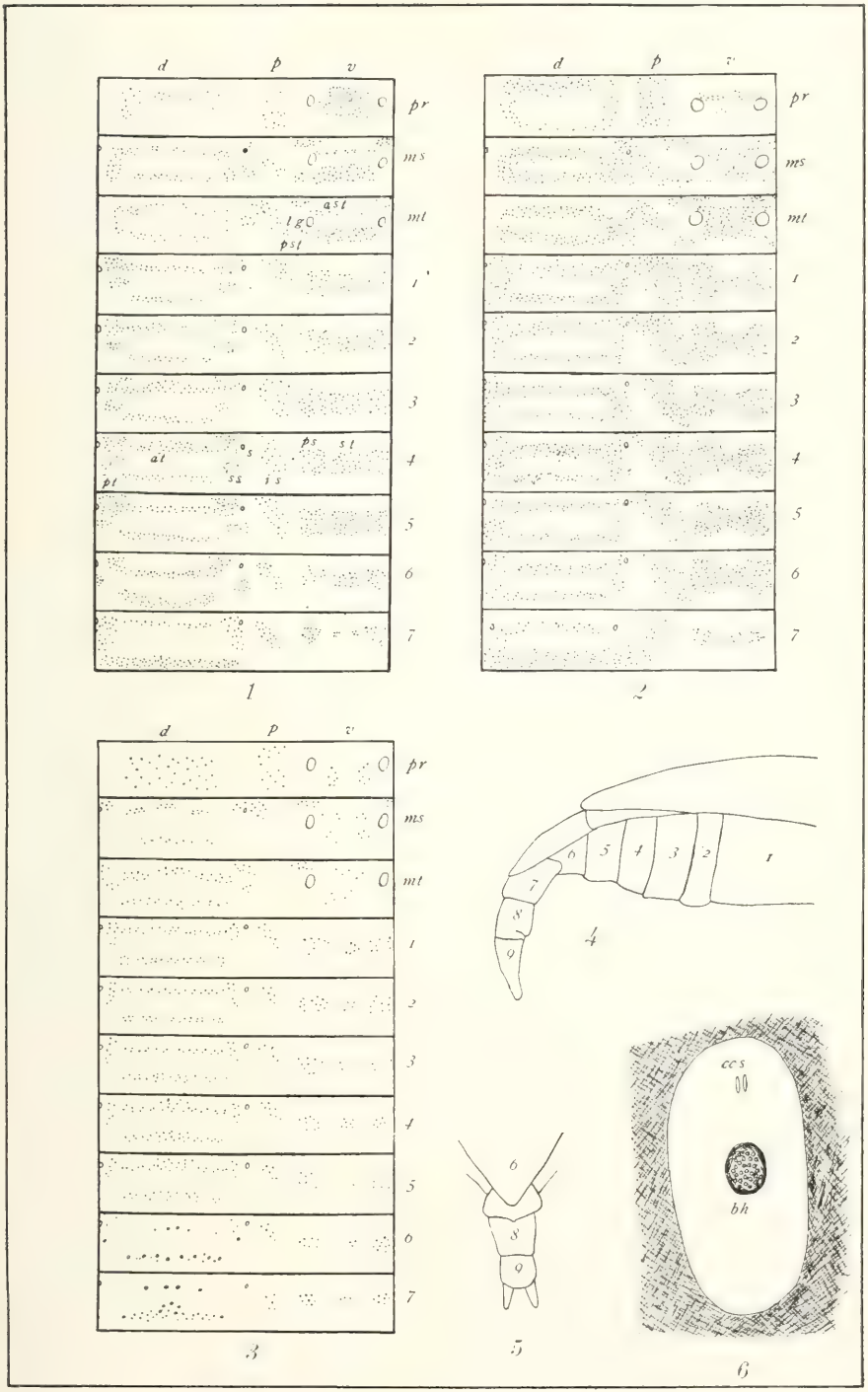
Anatomic details and the respiratory apparatus of Donacia palmata



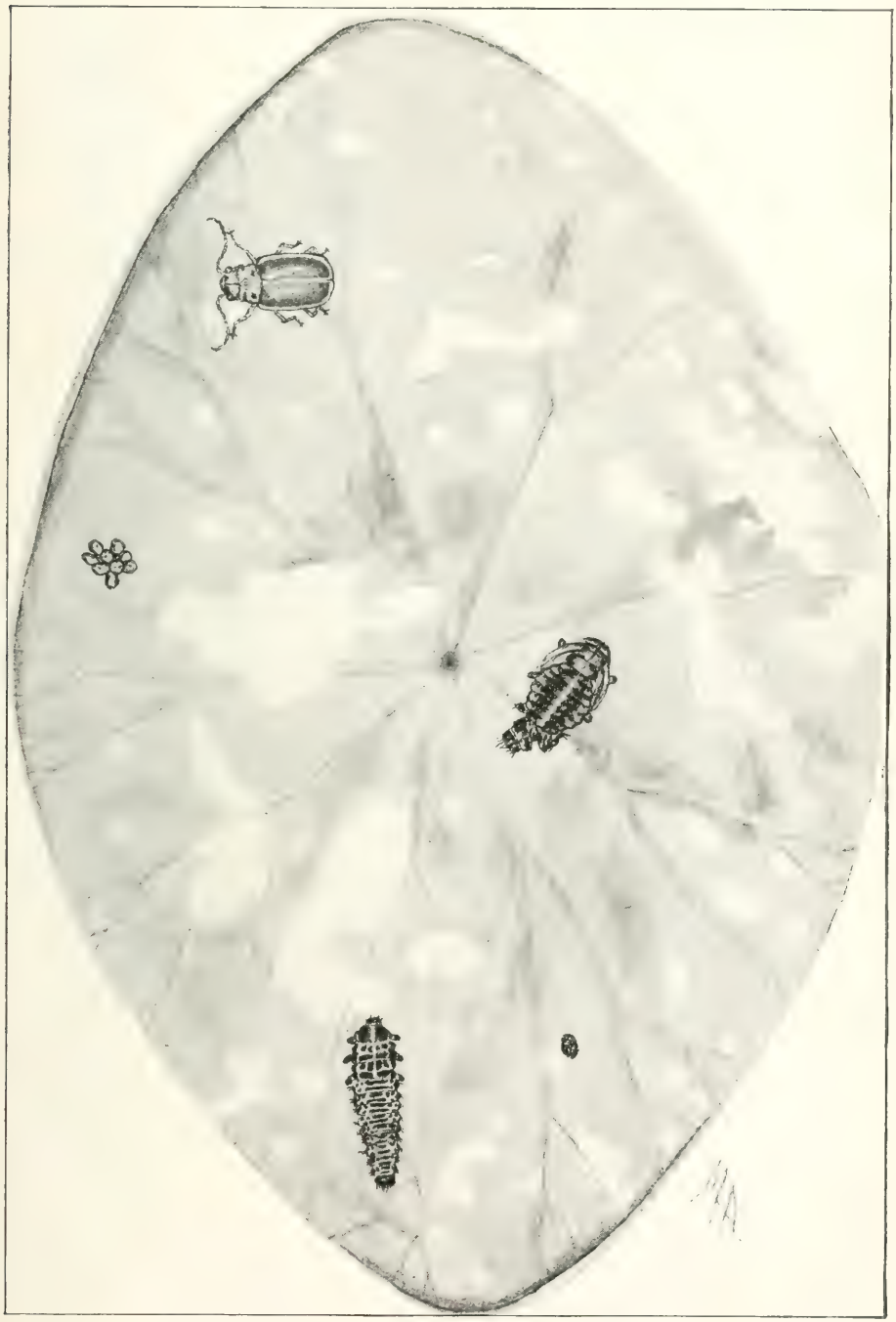
Anatomic details of the dorsal spines of Donacia palmata



Setal arrangement in Donacia larvae

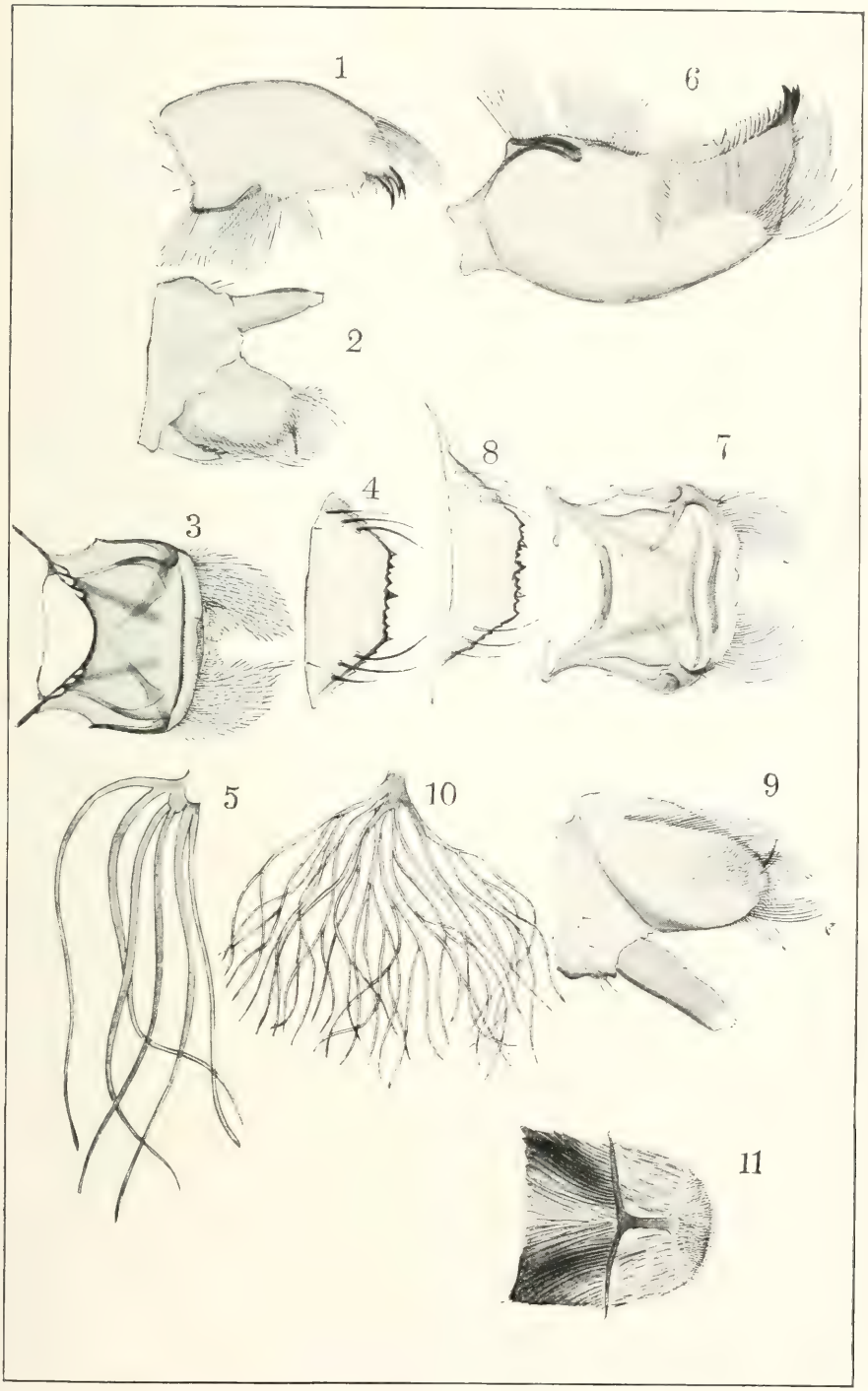


Setal arrangement in Donacia and Haemonia larvae and anatomic details of Donacia palmata

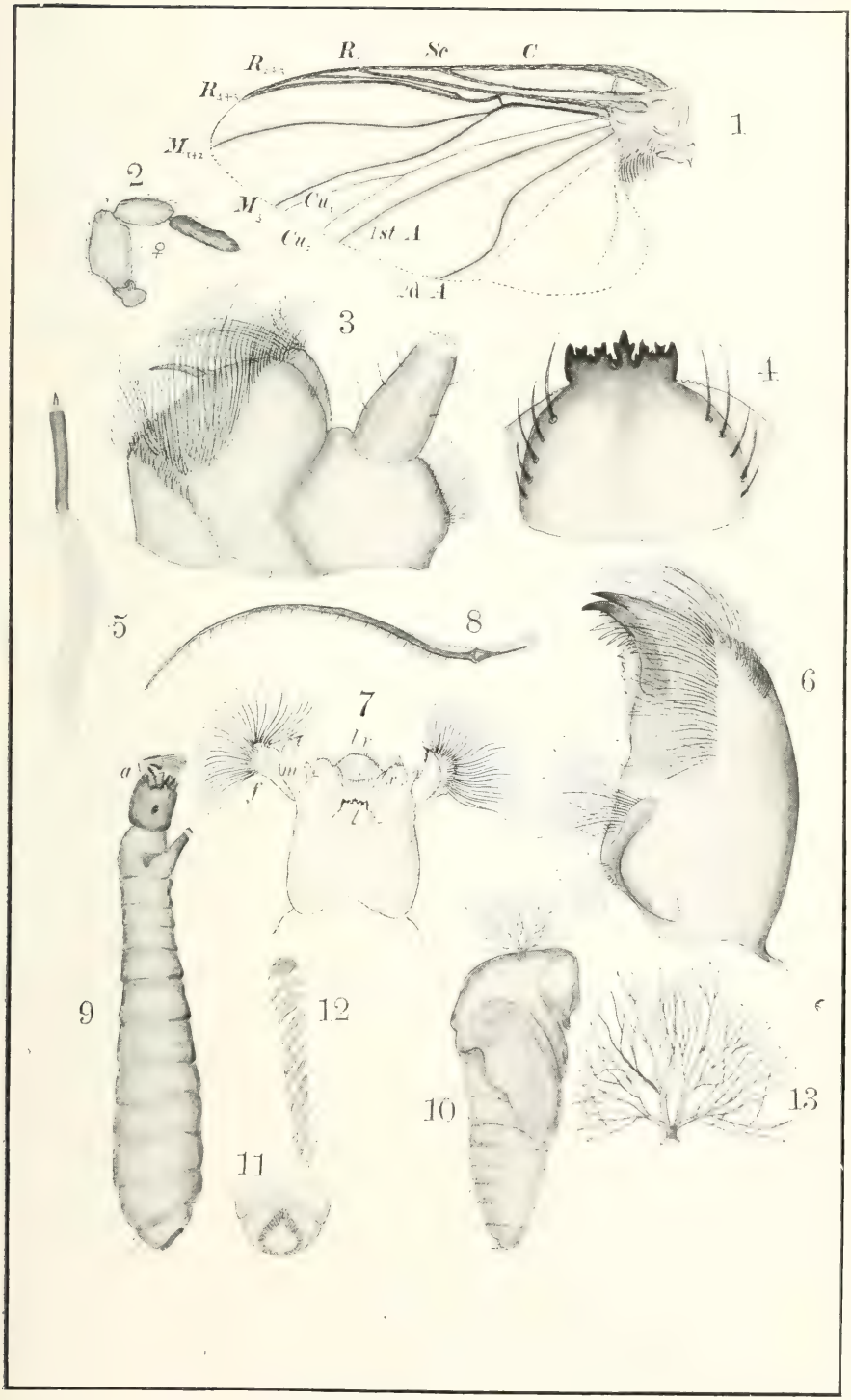


Food plant and transformations of Galerucella nymphaeae

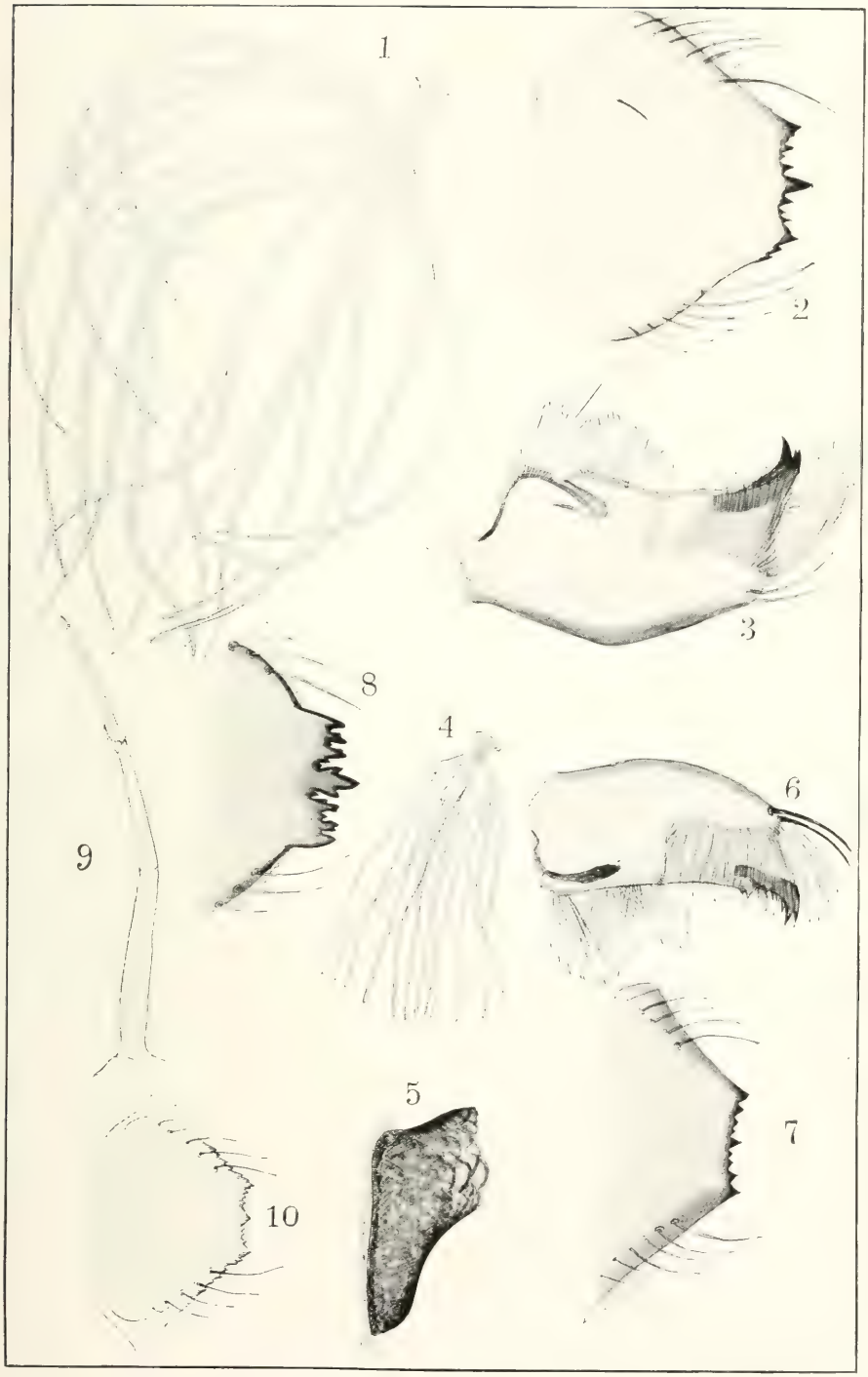
Cascadilla creek



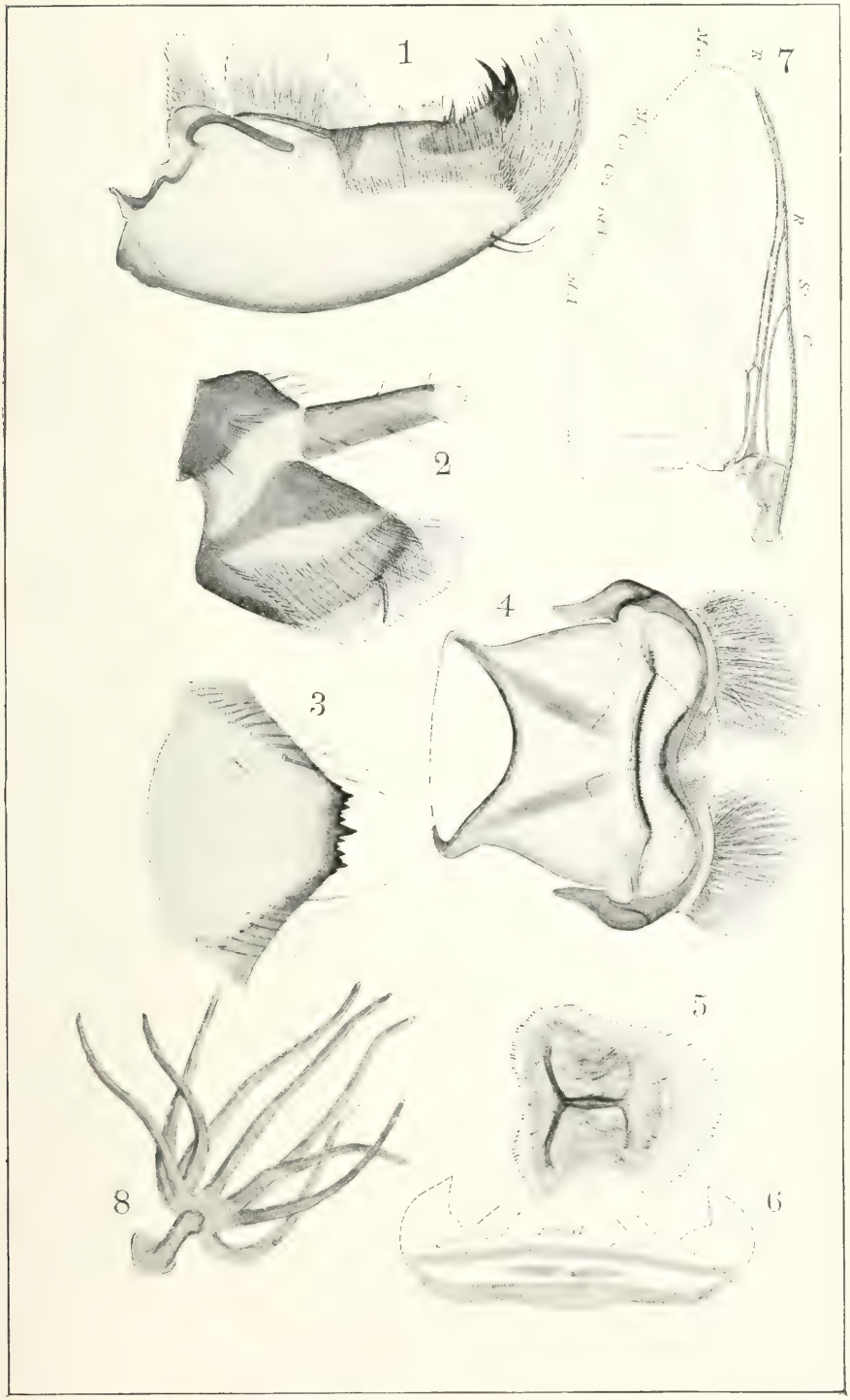
Details of Simulium larvae and pupae (S. pecuarum and meridionale)



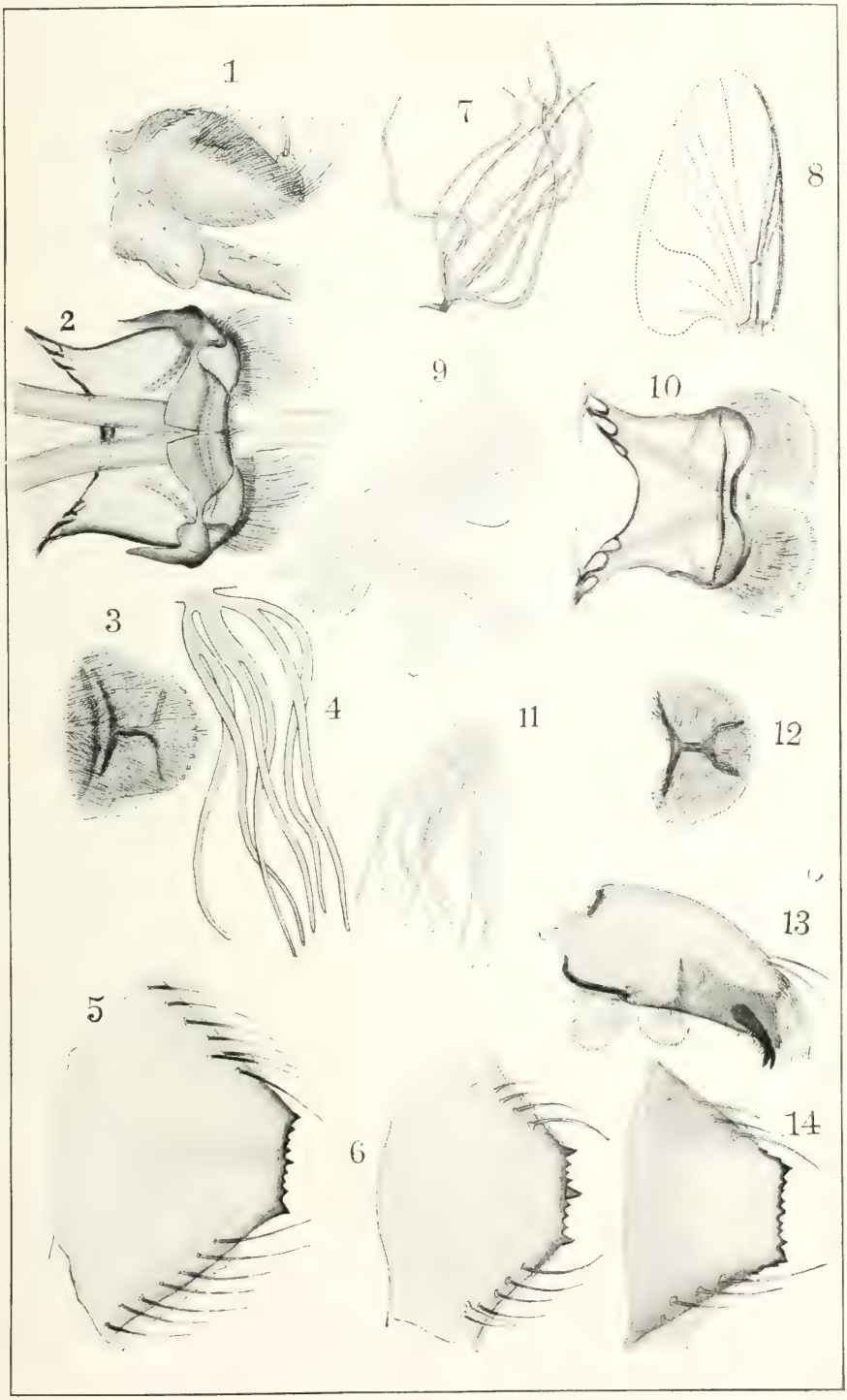
Simulium hirtipes



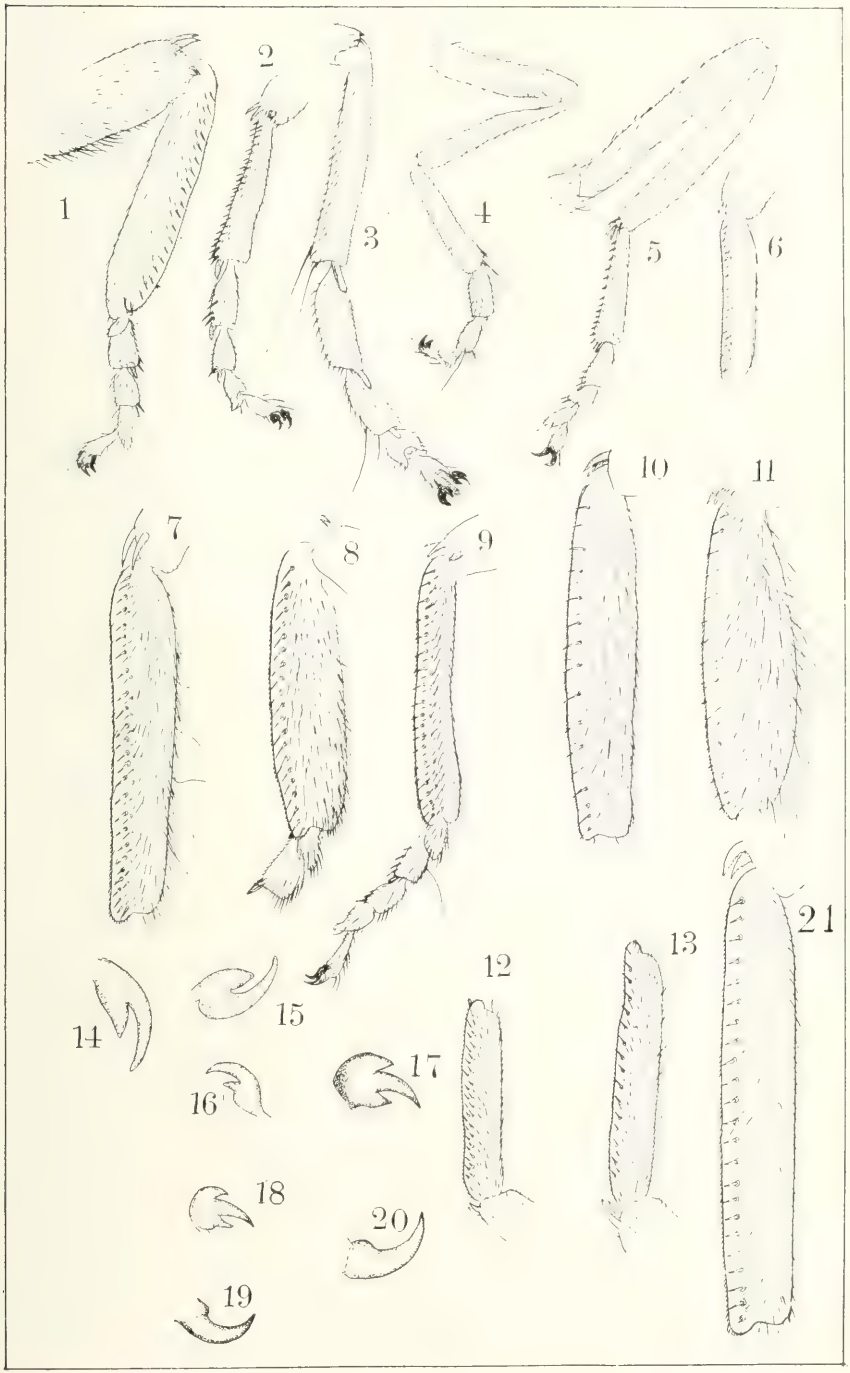
Details of Simulium larvae and pupae (S. vittatum and others)



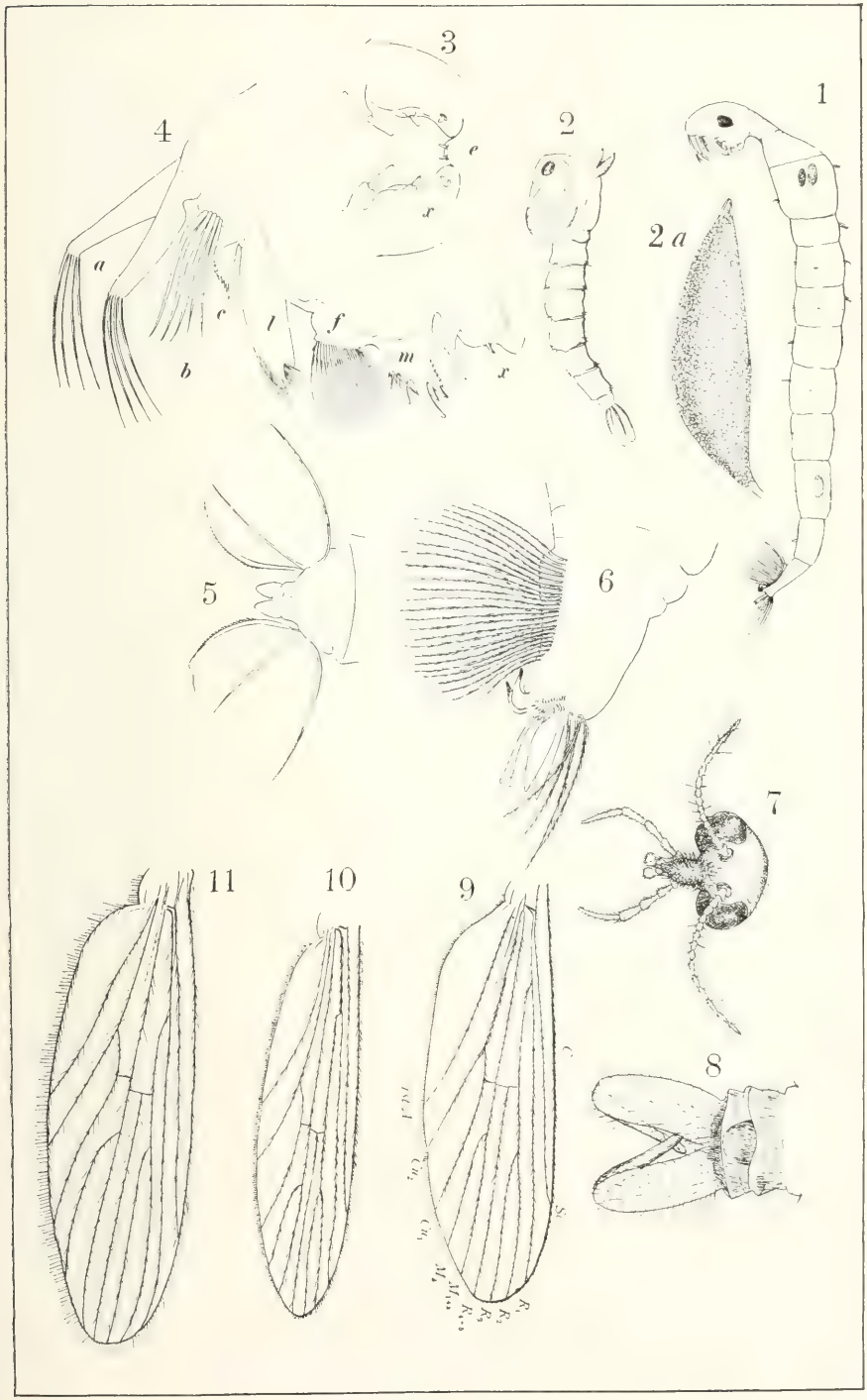
Simulium pictipes



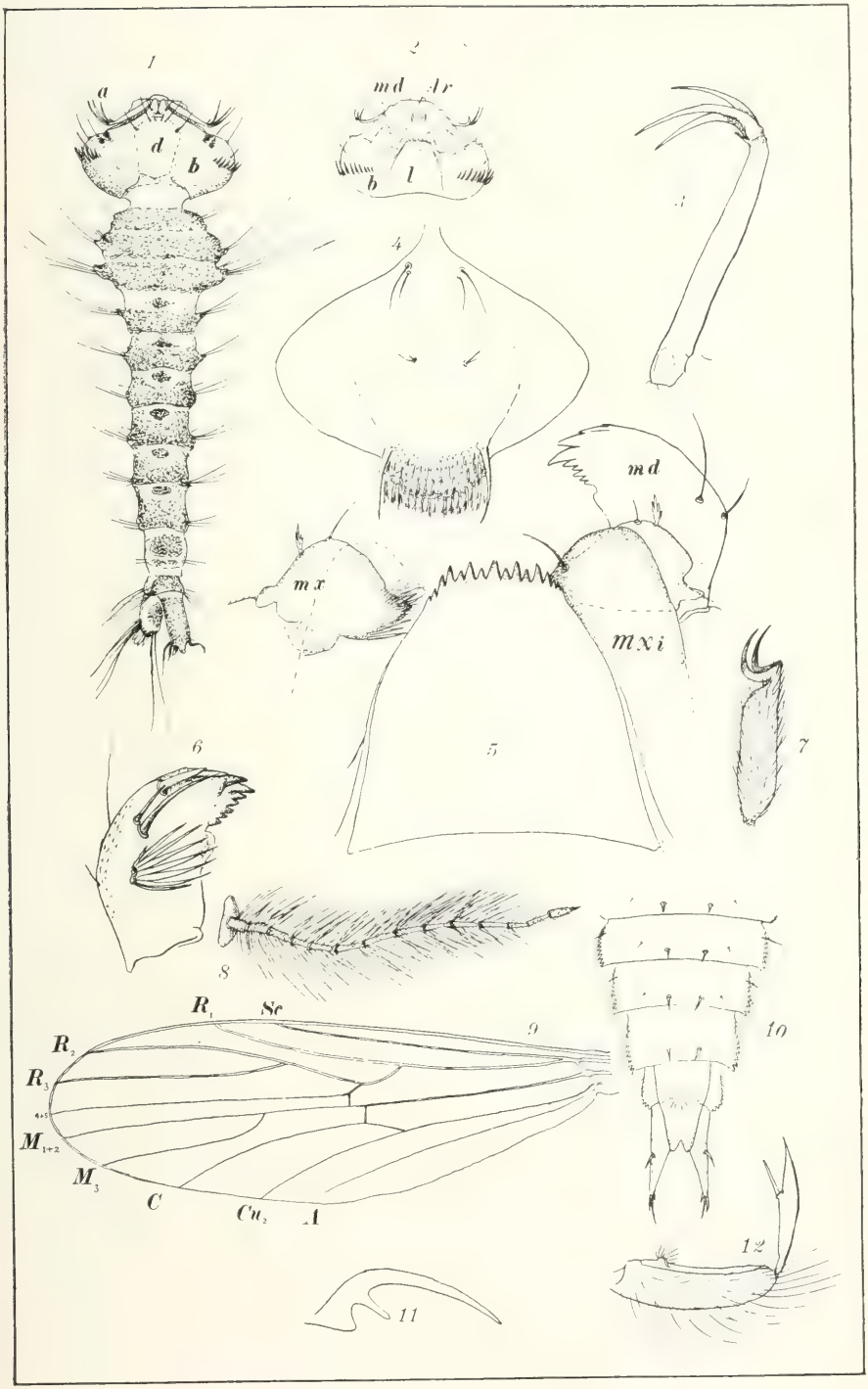
Simulium venustum



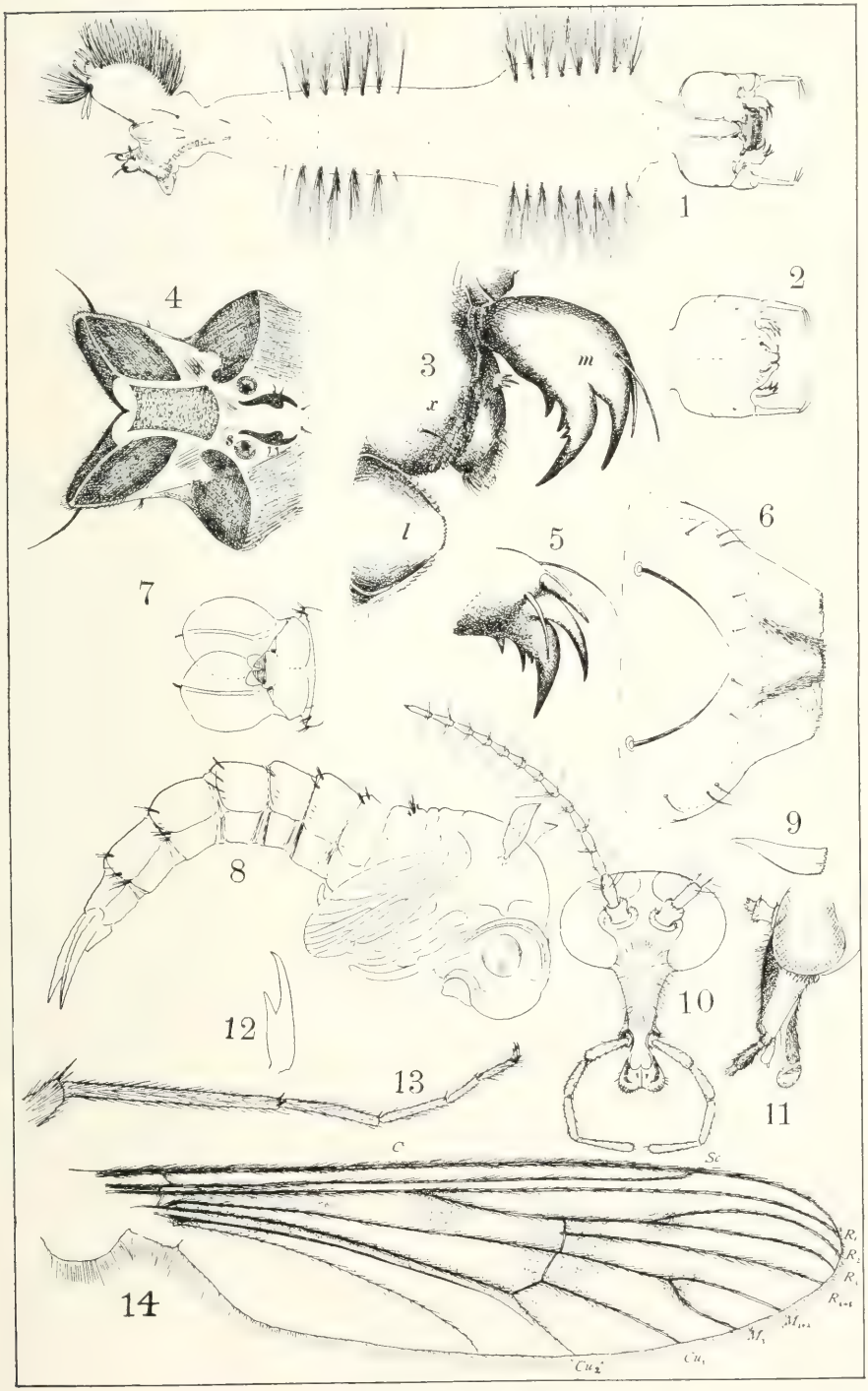
Legs and Claws of Simulium *sp.*



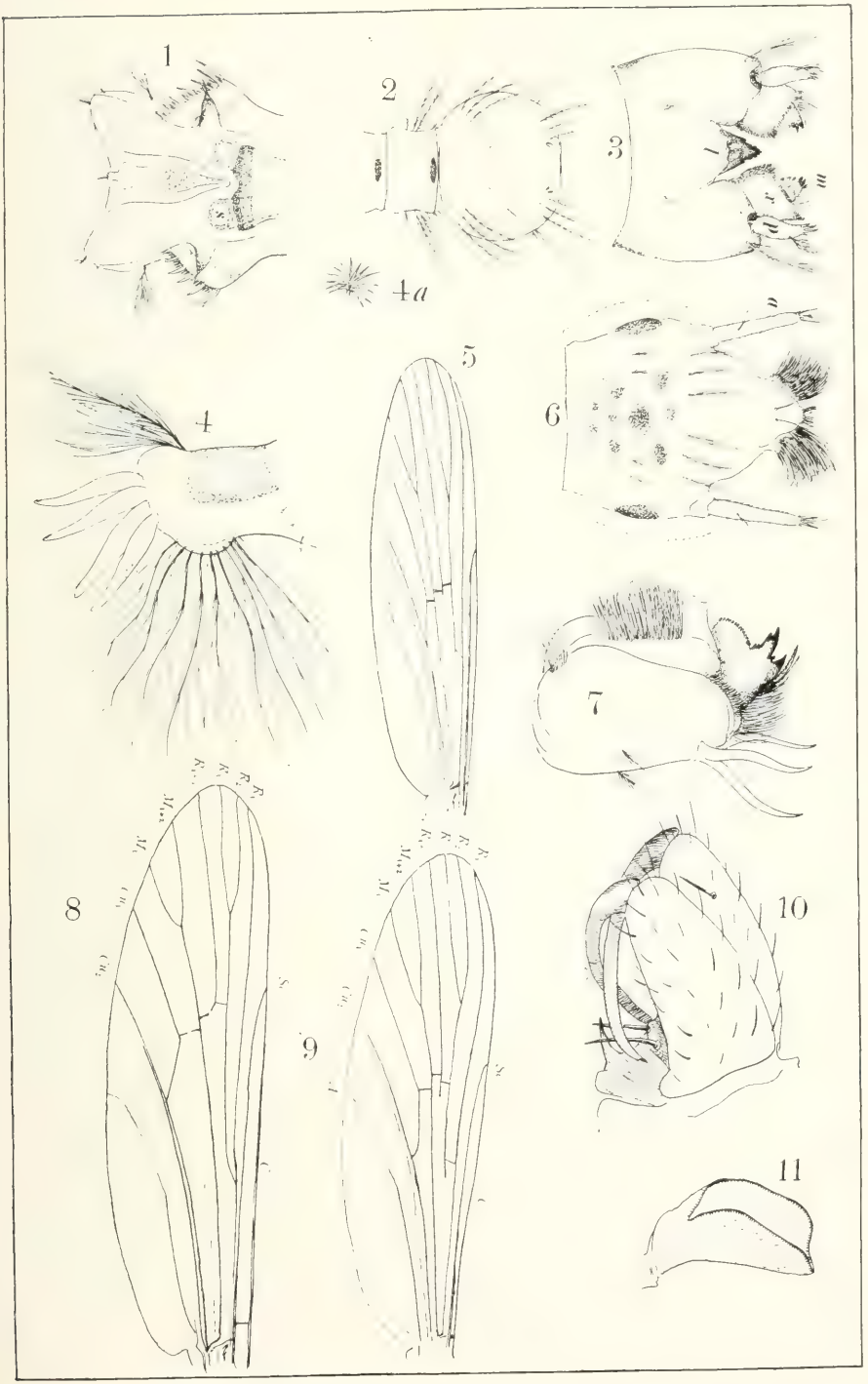
Corethra



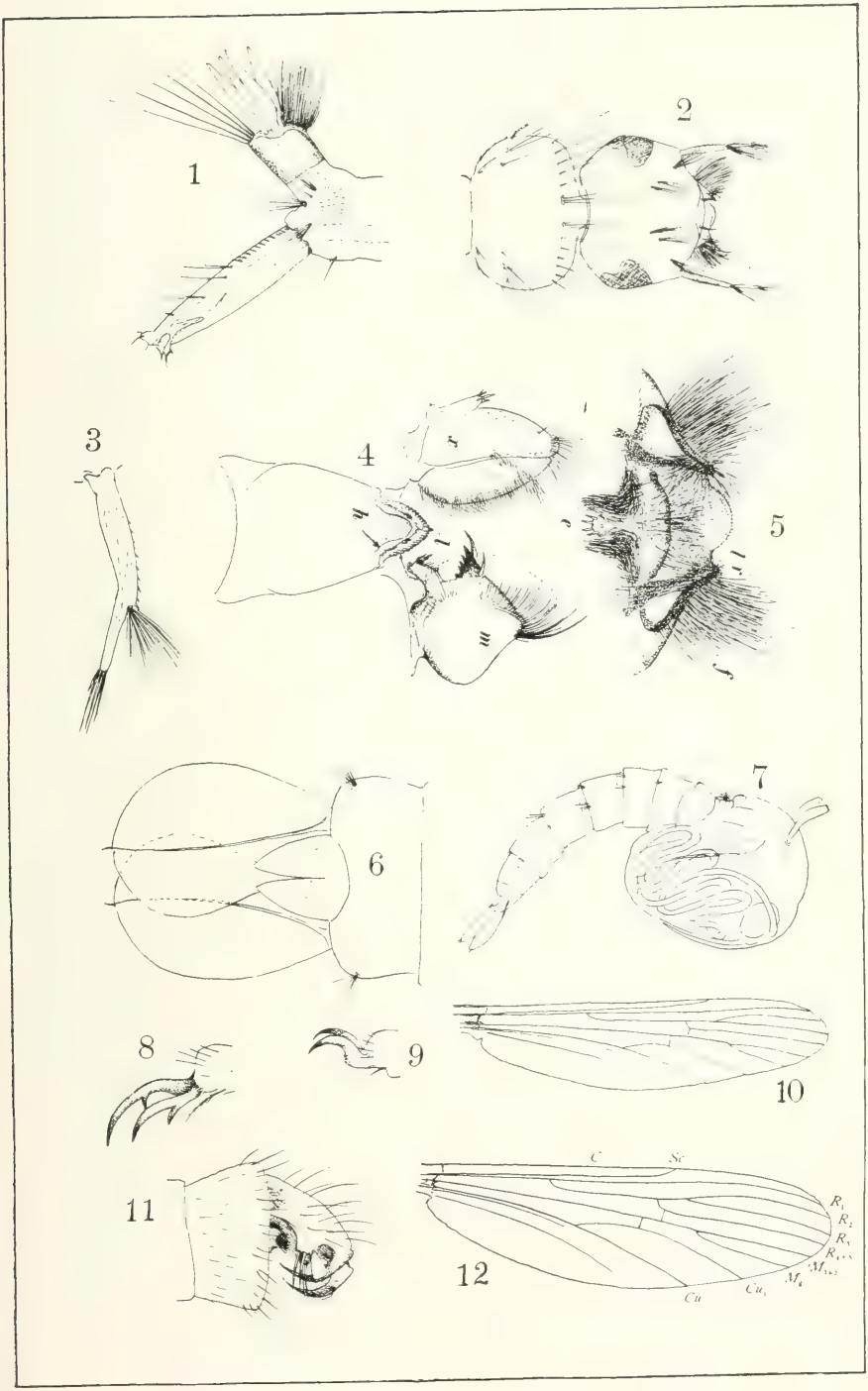
Corethrella brakeleyi



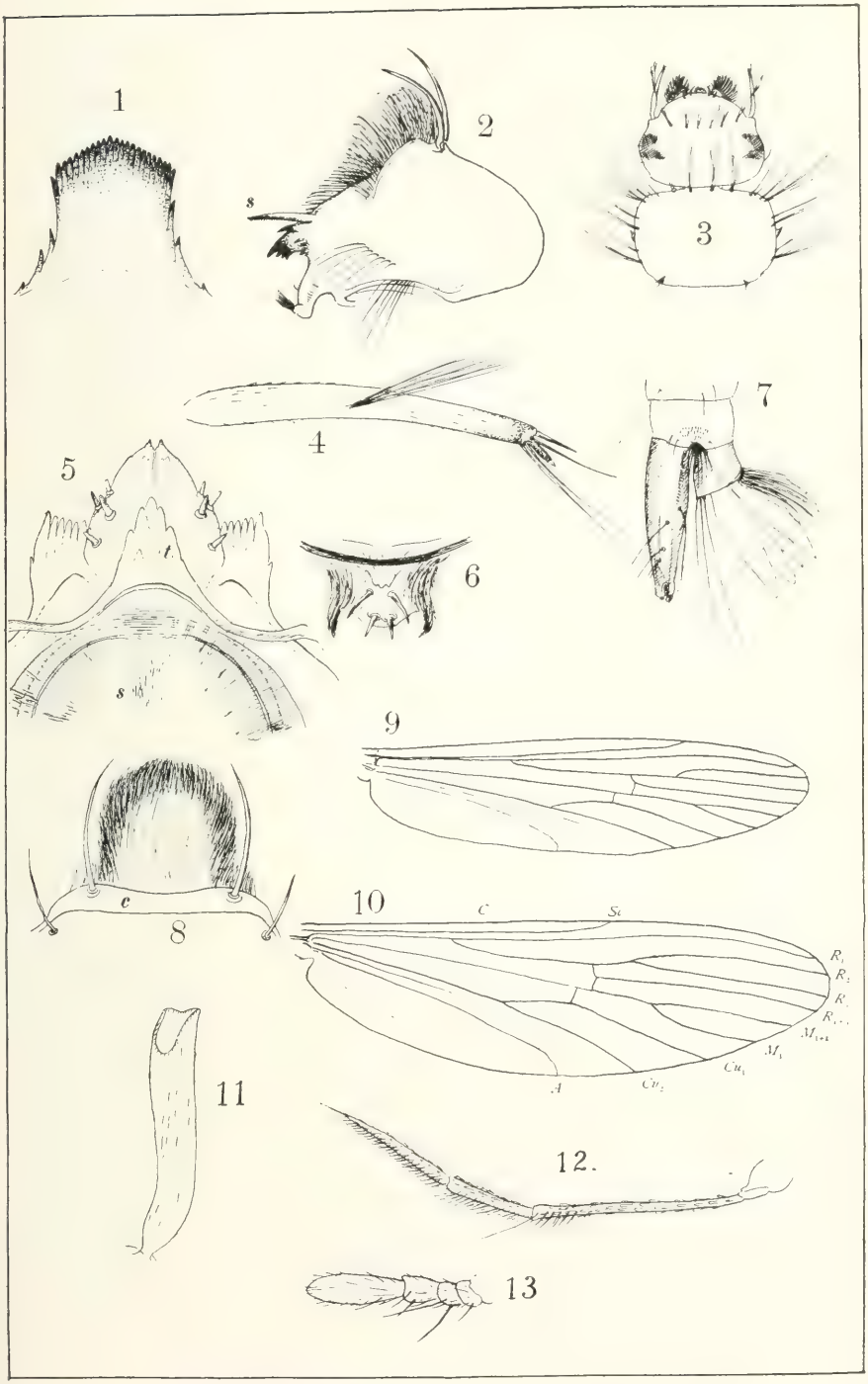
Pelorempis americana



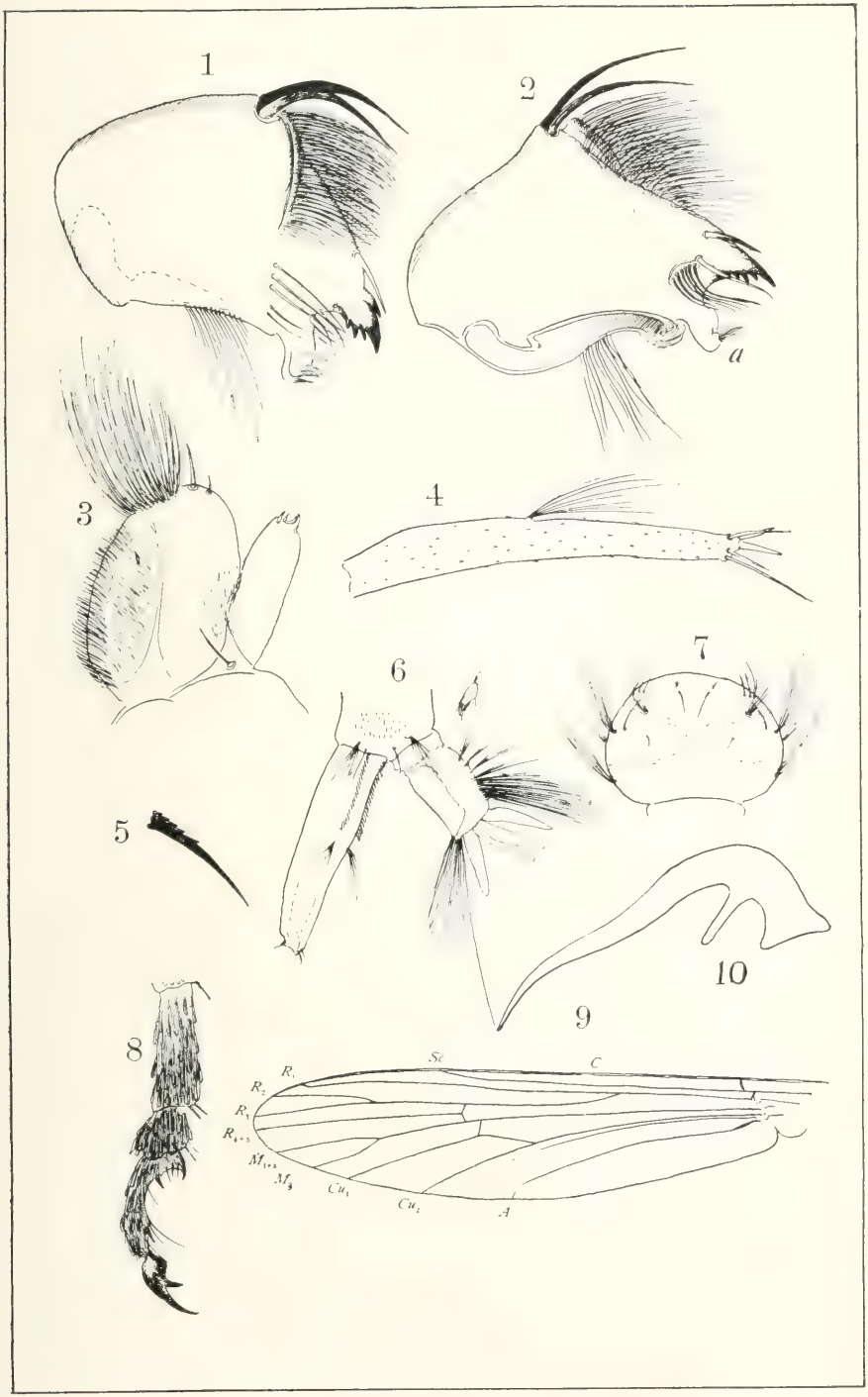
Anopheles and Psorophora



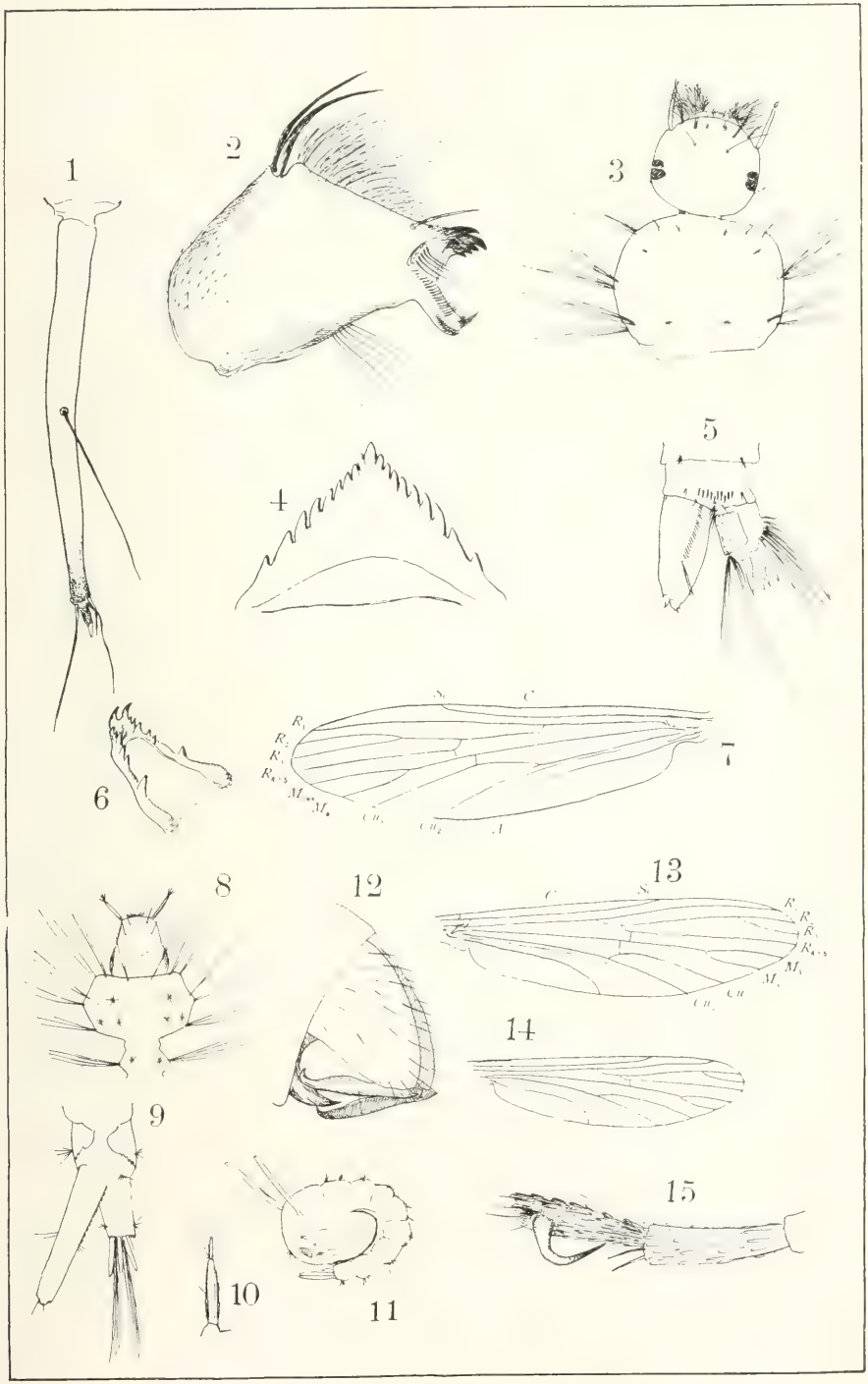
Culex pipiens



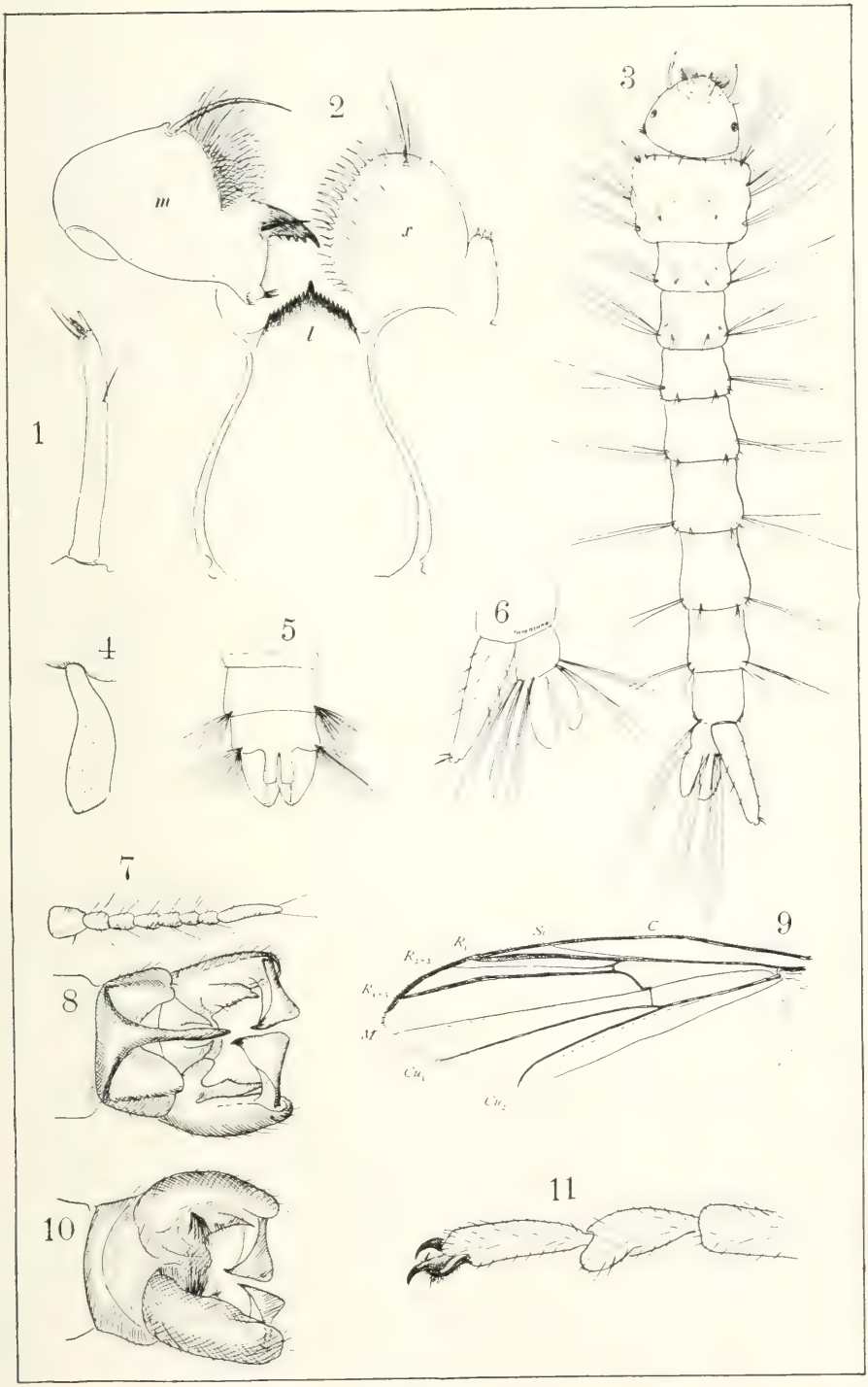
Culex restuans



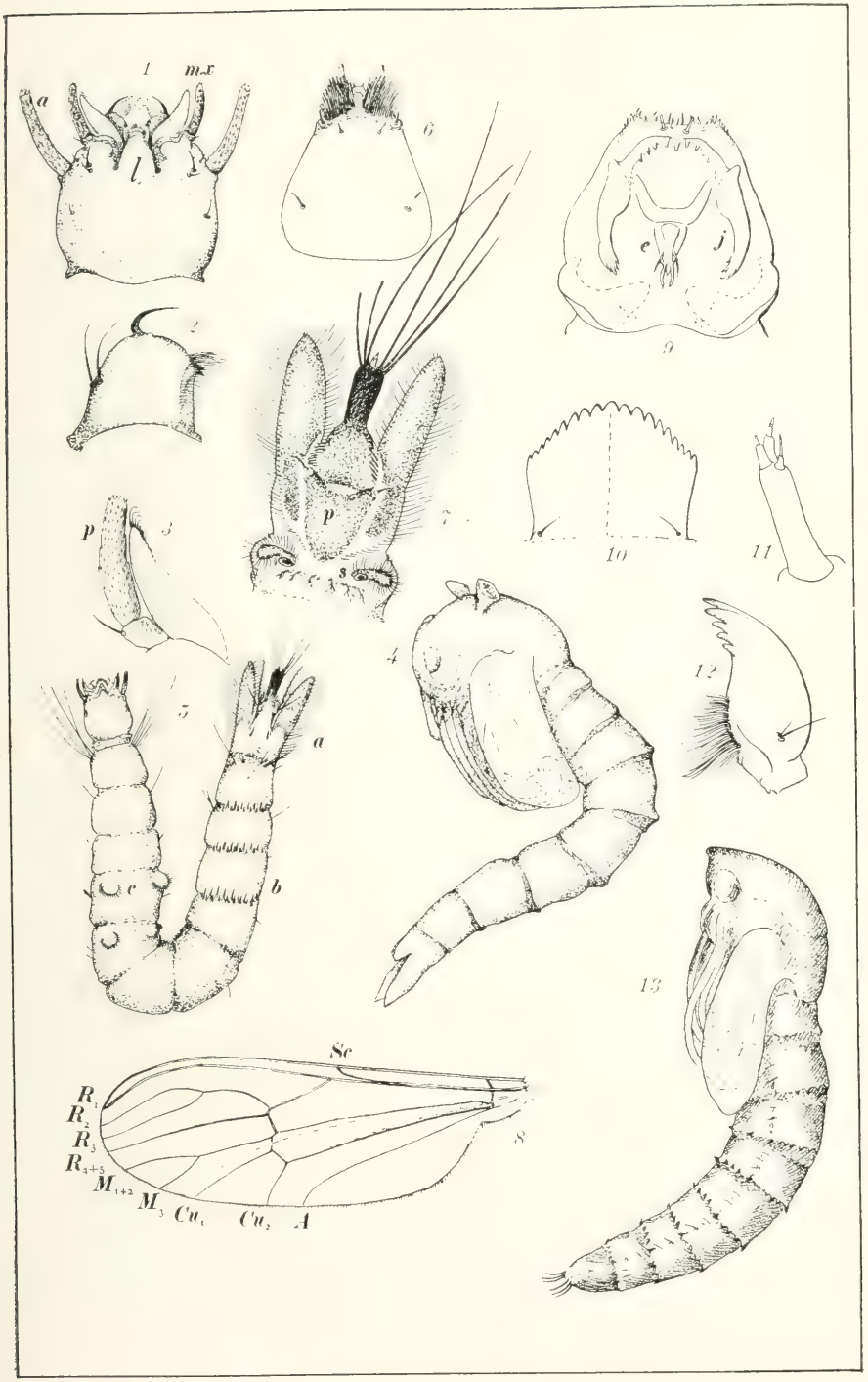
Culex cantans



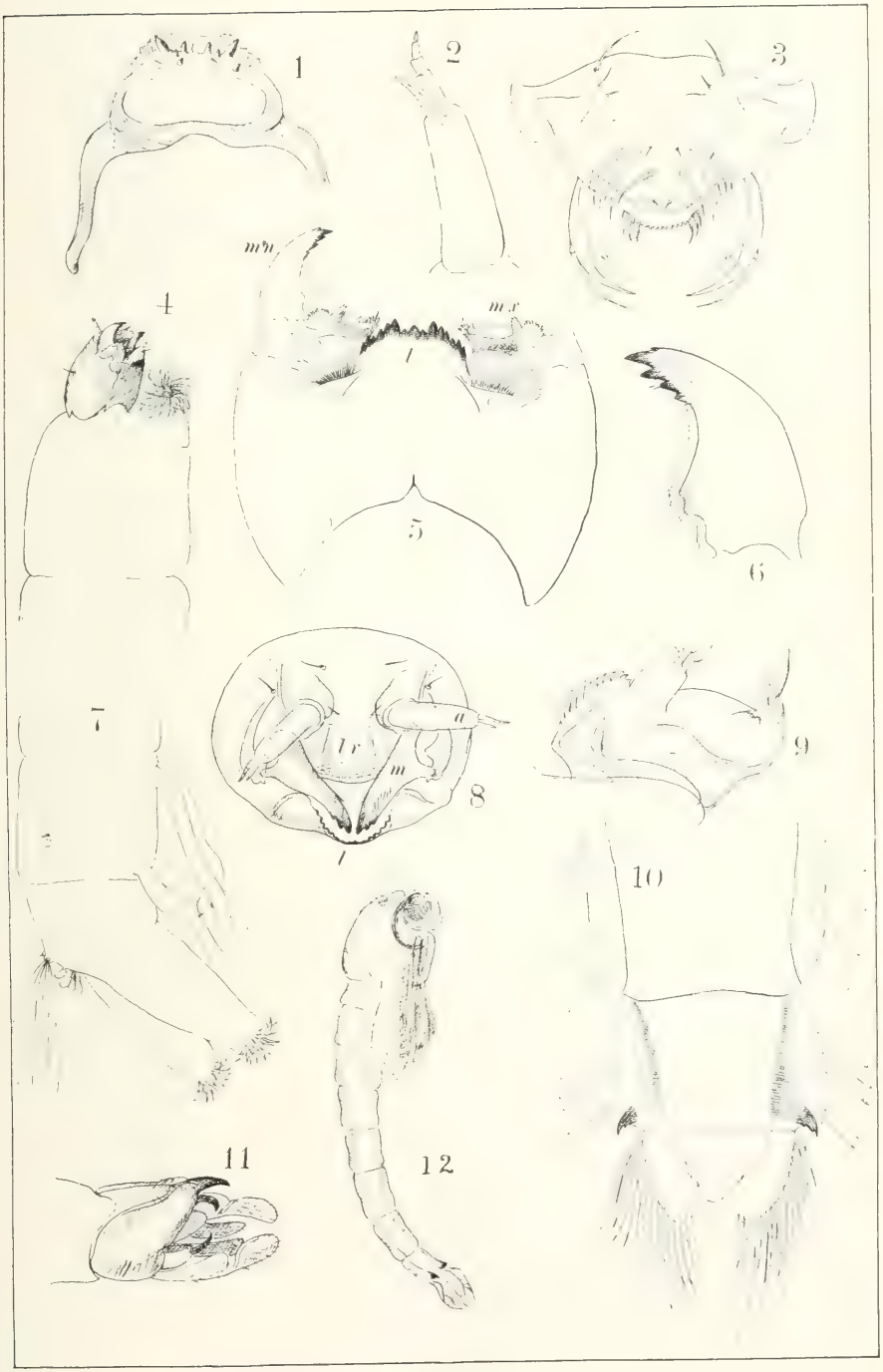
Culex triseriatus and Uranotaenia sapphirina



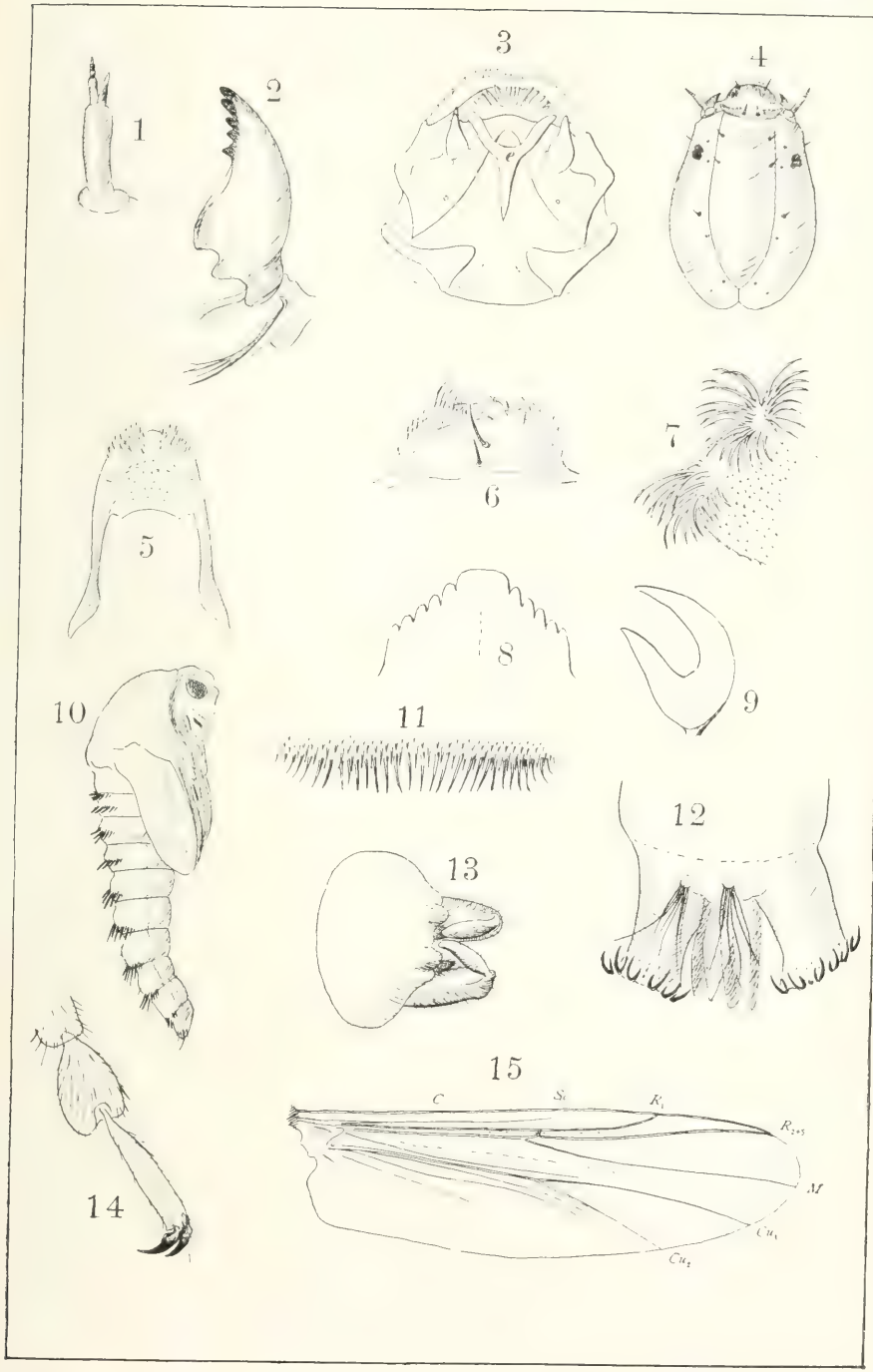
Aëdes smithii and Diamesa waltlii



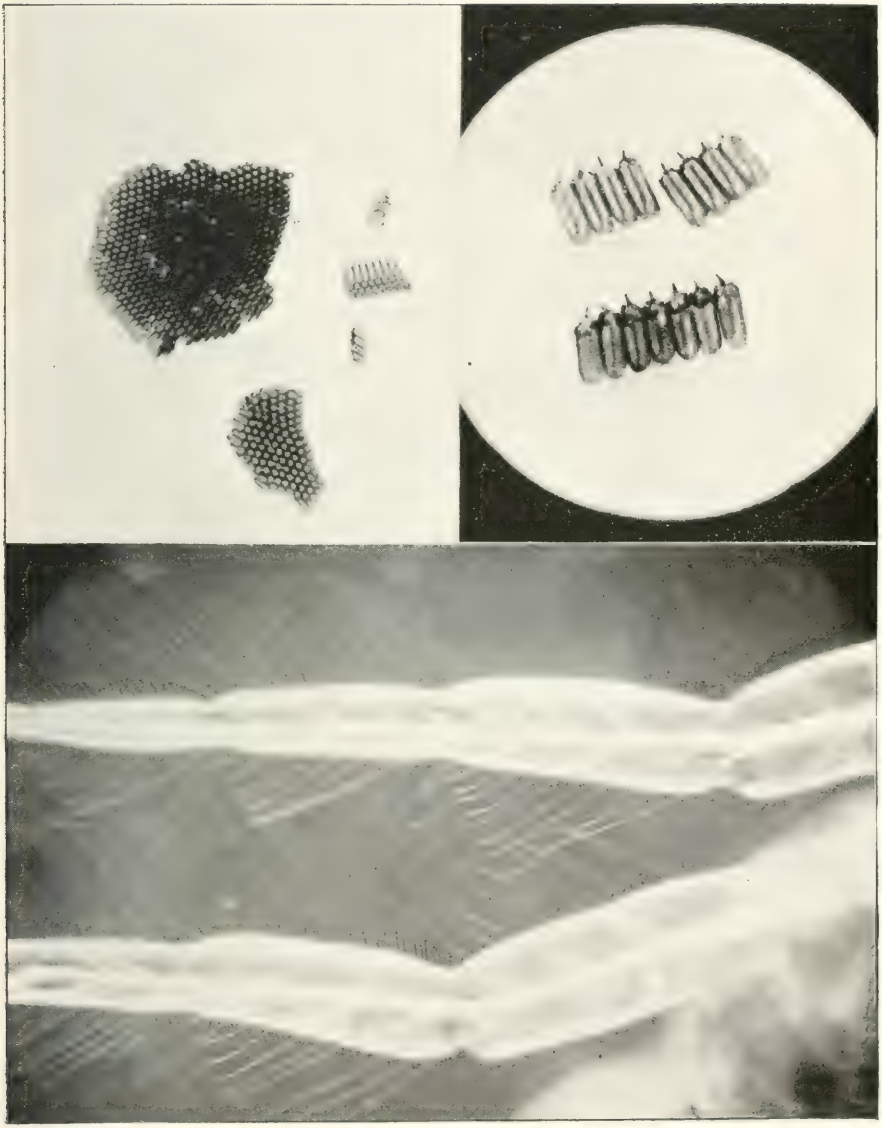
Dixa modesta and Diamesa waltlii



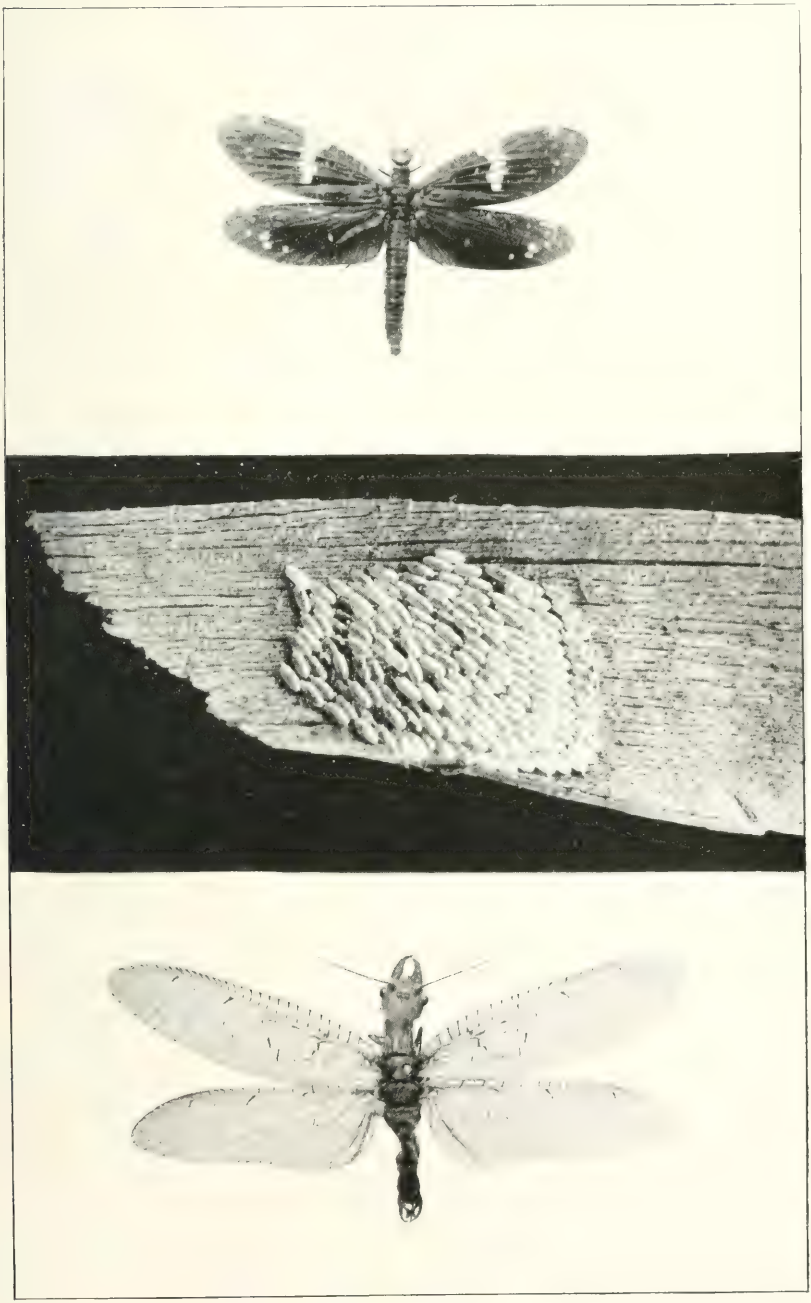
Chironomus



Thalassomyia obscura



Sialis infumata, eggs and lateral filaments



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